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UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 51 to 63, Inclusive, OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

PIGMENTS, PAINTS, AND VARNISHES

Paragraph 51:
- **Barytes.** (See par. 10)
- **Blanc Fixe.** (See par. 10)
- **Calcium Sulphate**
- **Satin White**

Paragraph 52:
- **Ferrocyanide Blues**
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- **Bone and Blood Char**

Paragraph 493:
- **White Enamel for Clock Dials**

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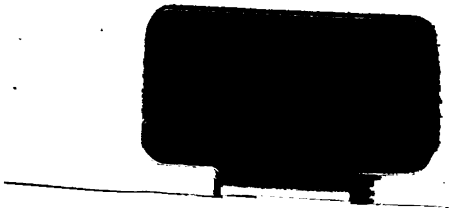

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

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AND RELATED ARTICLES IN OTHER PARAGRAPHS

PIGMENTS, PAINTS, AND [illegible]

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- Calcium [illegible]
- Satin White.

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UNITED STATES TARIFF COMMISSION.

Office: 1322 New York Avenue, Washington, D. C.

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PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and Index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report, the Tariff Commission had the services of Paul M. Tyler, of the metals division, and Dr. Grinnell Jones, C. R. DeLong, and Sidney D. Kirkpatrick, of the chemical division, of the Commission's staff, and of others.

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[Par. 63, n. s. p. f.]

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PIGMENTS, PAINTS, AND VARNISHES.

BARYTES AND BLANC FIXE.

(See paragraph 10.)

SATIN WHITE AND PRECIPITATED CALCIUM SULPHATE.

(Paragraphs 54 and 74, Act of 1913.)

GENERAL INFORMATION.

DESCRIPTION AND USES.

Tariff act of 1913.—Paragraph 51.—"* * * satin white, or artificial sulphate of lime, 20 per centum ad valorem."

Paragraph 74.—"* * * pearl hardening for paper makers' use; * * * 10 per centum ad valorem."

Satin white is a gelatinous aluminum hydroxide mixed with calcium sulphate and contains some free lime. It is made by precipitating a fairly strong aluminum sulphate solution with an excess of lime. It is used chiefly in coating or glazing paper.

Pearl hardening is the trade name used to designate an artificial crystallized calcium sulphate containing water of hydration. It is produced by adding sulphuric acid to a solution of calcium chloride, the calcium sulphate formed crystallizes from the solution with two molecules of water. This product is sold under the trade name given above for use as a filler in the manufacture of paper.

Precipitated calcium sulphate is calcium sulphate obtained by precipitation from a solution of calcium chloride by means of Glauber salts (sodium sulphate). It is obtained as a by-product of many chemical processes and may be obtained in large quantities at a fairly low price. The commercial product is usually dry and does not contain any water of hydration as does pearl hardening. In addition to being used in the manufacture of paper, it is used also as an inert pigment or filler in the manufacture of paints and for other purposes.

Satin white and artificial sulphate of lime are used synonymously in paragraph 51. While as a matter of fact they are distinct articles of commerce, artificial sulphate of lime is used for the same purpose as satin white. Precipitated calcium sulphate is also used as land plaster, as a corrective for certain soils which are lacking in calcium.

DOMESTIC PRODUCTION.

Figures for the domestic production of these commodities are not available. It is believed, however, that the domestic production is sufficient to meet all domestic requirements. The imports are comparatively small. Calcium sulphate, which is also the basis of pearl hardening, may be obtained, as a by-product of many chemical processes, in the United States at a relatively low cost. Aluminum and lime, the necessary materials for the manufacture of satin white, are available in this country in large quantities.

IMPORTS INTO THE UNITED STATES.

Imports of "satin white or artificial sulphate of lime" are combined with those of blanc fixe, or artificial barium sulphate. Pickrell [1] shows that in 1914 the imports of calcium sulphate, pure precipitated, amounted to 75,473 pounds, valued at $880, all of which came from Germany. Imports of pearl hardening have been small; the maximum prewar import was valued at $9,680 in 1911. Since then they have shown a gradual decline to as low as $30 in 1918.

PRICES.

Domestic prices are not available in trade journals on these commodities.

TARIFF HISTORY AND CONSIDERATIONS.

A provision for "satin white, or artificial sulphate of lime," has appeared on the dutiable list of all tariff acts from 1894 to 1913, inclusive. The duty was 25 per cent ad valorem in the act of 1894, ½ cent per pound in the acts of 1897 and 1909, and 20 per cent ad valorem in the act of 1913. In the act of 1897 a provision for "pearl hardening for paper makers' use" was inserted and has appeared in all subsequent tariff acts. The duty on this commodity was 20 per cent ad valorem in the acts of 1897 and 1909, and was reduced to 10 per cent ad valorem in the act of 1913.

In a decision (T. D. 17505) under the act of 1894, pearl hardening was declared dutiable as artificial sulphate of lime. In another decision (T. D. 19581) under the act of 1897 artificial sulphate of lime, which was imported and invoiced as pearl hardening, was assessed for duty as artificial sulphate of lime under paragraph 46, but under protest by the importer was declared dutiable as pearl hardening for paper makers' use under paragraph 91.

As all of these commodities—satin white, pearl hardening, and artificial calcium sulphate—are somewhat similar in composition and are used for the same purpose, they might well be included in one paragraph. As previously pointed out, satin white and artificial sulphate of lime are used synonymously in paragraph 51; the conjunction "or" should be changed to "and". Precipitated calcium sulphate is a better description than artificial sulphate of lime. "Pearl hardening for paper makers' use" is artificial calcium sulphate, although natural calcium sulphate (gypsum) may be used for this purpose, but the artificial is preferred. Pearl hardening, the artificial product, is provided for under paragraph 51 by the words "artificial sulphate of lime." If it should be the natural product, it is provided for by the provision for "plaster rock or gypsum" which precedes it in paragraph 74. It would be well to include pearl hardening in the description of precipitated calcium sulphate. Satin white, precipitated calcium sulphate, and pearl hardening are not related to the other products of paragraph 51 and might well be included in a separate paragraph as follows:

"Satin white and precipitated calcium sulphate including pearl hardening (rate)."

[1] Pickrell, Dr. E. R. "Chemical and Allied Substances in the United States," Department of Commerce, Miscellaneous Series No. 82.

Pearl hardening, for paper makers' use—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1908	20 per cent		$5,452	$1,090		20.00
1909	do		7,942	1,588		20.00
1910	do		5,821	1,164		20.00
1911	do		9,680	1,936		20.00
1912	do		6,679	1,335		20.00
1913	do		8,612	1,722		20.00
1914	do		1,711	342		20.00
1914	10 per cent		3,583	358		10.00
1915	do		3,609	360		10.00
1916	do		593	59		10.00
1917	do		183	18		10.00
1918	do		30	3		10.00
1919	do		420	42		10.00

Satin white and artificial calcium sulphate—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1894	39	* * * and satin white, or artificial sulphate of lime	25 per cent ad valorem.
1897	46	* * * and satin white, or artificial sulphate of lime	½ cent per pound.
	91	* * * pearl hardening for paper makers' use	20 per cent ad valorem.
1909	44	* * * and satin white, or artificial sulphate of lime	½ cent per pound.
	88	* * * pearl hardening for paper makers' use	20 per cent ad valorem.
1913	51	* * * and satin white, or artificial sulphate of lime	20 per cent ad valorem.
	74	* * * pearl hardening for paper makers' use; * * *	10 per cent ad valorem.

FERROCYANIDE BLUES.

[Par. 52, act of 1913, 20 per cent ad valorem.]

SUMMARY.

Next to ultramarine, the ferrocyanide blues are the most important blue pigments. They are also blended with chrome yellow for the manufacture of chrome green, which is the most used green pigment. Small quantities are employed to tone bone black, intensifying the color.

Prior to 1914, potassium ferrocyanide was used for the manufacture of these colors, but the shortage of potash which followed the cutting off of German supplies resulted in the substitution of sodium ferrocyanide. The cost of ferrocyanide represents nearly two-thirds of the selling price of the finished pigment. Copperas is the only other raw material. The manufacture calls for extensive tank equipment, and washing and filtering are slow and difficult. The slowness of the process introduces heavy interest charges for both plant and material. Labor does not constitute a very great percentage of the final cost. The industry is becoming concentrated in a small number of large establishments, since the manufacture can not be conducted profitably in small color works. Nearly 95 per cent of the 1914 output was produced in 10 establishments

located in or near New York. The total production in that year was nearly one and one-quarter million pounds, with a value of $387,077.

Prussian blue is manufactured in great quantities in Germany, France, and England. The German product was an active factor in the domestic market before the war. Foreign manufacturers were at a considerable advantage as regards the cost of their raw material; nearly 50 per cent of the domestic supply of ferrocyanides was imported into the United States in the years just preceding the war.

Imports of Prussian blue averaged about 190,000 to 200,000 pounds annually prior to 1913, but increased considerably under the act of 1913.

Prussian blue—Summary table.

Calendar year.	Domestic production.	Imports for consumption.	Ratio of imports to production.
	Pounds.	*Pounds.*	*Per cent.*
1911	.....	167,002	.....
1912	.....	172,905	.....
1913	.....	221,827	.....
1914	1,239,382	380,573	30.79
1915	.....	409,543	.....
1916	.....	447,362	.....
1917	.....	23,892	.....
1918	.....	2,923	.....
1919	.....	16,055	.....
1920 [1]	.....	286,830	.....

Calendar year.	Value (imports for consumption.)	Amount of duty.	Value per unit.	Equivalent ad valorem rate.
				Per cent.
1911	$29,482.00	$13,360.16	$0.177	45.3
1912	31,229.00	13,832.40	.180	44.2
1913	40,917.00	14,560.92	.184	35.7
1914 [2]	73,077.00	14,615.40	.192	20.0
1915 [2]	102,504.00	20,500.80	.250	20.0
1916 [2]	281,850.00	56,366.40	.628	20.0
1917 [2]	17,999.00	3,599.80	.752	20.0
1918 [2]	3,100.00	620.00	1.066	20.0
1919 [2]	5,862.00	1,172.00	.365	20.0
1920 [1]	118,046.00	23,609.00	.425	20.0

[1] Six months ending June 30, 1920.
[2] Includes only, in pulp, dry or ground in or mixed with oil or water.

General Information.

PARAGRAPH 52, TARIFF ACT OF 1913.

Blues, such as Berlin, Prussian, Chinese, and all others containing ferrocyanide of iron, in pulp, dry or ground in or mixed with oil or water, 20 per cent ad valorem; * * *.

DESCRIPTION.

Prussian blue or Berlin blue is the ferrocyanide of iron (ferriferrocyanide, $Fe_4[Fe(CN)_6]_3$. There are many varieties which are made by slightly different processes and sold under the names Steel blue, Milori blue, Bronze blue, Antwerp blue, Chinese blue, Paris blue, etc. The name Berlin blue, formerly used in commerce, and which appears

in the tariff law and in the classifications of the Department of Commerce, is practically obsolete at the present time. Prussian blue is the standard blue of this group. Chinese, Celestial, and Milori blues are of somewhat lighter shades, although quite similar chemically. Bronze blue has a peculiar metallic sheen or luster whereas Steel blue has not. All the above are made from a soluble ferrocyanide and iron salts.

Toch [1] bases his distinction upon the availability of the different blues for the production of pale-blue shades:

> Prussian blue * * * is like a mixture of indigo and black in its dry state, and when tinted with 100 times its own weight of zinc oxide the shade produced is a muddy violet. Chinese blue, when treated in the same manner, gives a purer blue which has no trace of violet in the shade. The Steel blue, when diluted 100 times, gives a turquoise shade.

Soluble Prussian blue was formerly used as blue ink and is still used in many kinds of laundry bluing, etc. It is also employed by anatomists for injecting preparations of tissues, veins, and arteries. The composition is ferrocyanide of iron made soluble by treatment with concentrated ferric salts or by dissolving in mineral acids and precipitating again. Oxalic acid is also used in the process. True soluble blue invariably contains potash, the dry substance (i. e. when dried at 100° C.) corresponds to the formula:

$2KFe^{***}Fe^{***}(CN)_6 3\frac{1}{2}H_2O$ (*v.* Thorpe. Dictionary of Applied Chemistry) and may be obtained directly by the incomplete precipitation of potassium ferrocyanide by means of iron salts.

Turnbull's blue has the same composition as Prussian blue although it is made by precipitating a ferrous salt with potassium (sodium) ferricyanide, $K_3Fe(CN)_6$, instead of the ferrocyanide, $K_4Fe(CN)_6$. It formerly sold at a higher price than Prussian blue. But it is really inferior in many respects to Prussian blue and has practically disappeared from the market.

Antwerp blue is a mixture of iron and zinc cyanogen compounds. It is prepared by mixing variable quantities of iron and zinc sulphates in solution and precipitating them with potassium ferrocyanide.

USES.

Next to ultramarine, the ferrocyanide blues are the most important blue pigments and large quantities are absorbed in the manufacture of chrome green. Small quantities are used with bone-black to produce intensely black or blue-black shades.

Prussian blue is strictly a glaze pigment (i. e. semitransparent), but of such intensity and coloring power that, in a concentrated state, it acts as a covering pigment. It fades a little on exposure to light but regains its color in the dark.[2] It mixes well with oil, but unless it has been thoroughly washed may have a slight yellowing effect. It is not largely used for the production of pale-blue tints. When mixed with white lead, Prussian blue changes color in the can, becoming a pale green. Zinc oxide mixtures have the same action although not so marked. When actually applied to an exterior surface, however, these discolored mixtures regain their pristine blue color. Prussian blue can not be mixed with any substances that give

[1] Chemistry and Technology of Paints. Van Nostrand, 1916.
[2] Zerr, Rübenkamp, and Mayer. Treatise on color manufacture. Griffin & Co., 1908.

an alkaline reaction without suffering a change in shade. It is destroyed by strong alkalies and acids but resists weak acids and acid fumes in the air very well, and weak alkalies (e. g. soap) have a comparatively slow action on it.

SUBSTITUTES.

Artificial cobalt blue (a form of ultramarine) is much superior to Prussian blue for the preparation of pale tints and ultramarine is an almost universal substitute in many of the deeper shades of paints provided resistance to acid is not required. Ultramarine can not be used, however, in the preparation of chrome green which is a mixture of the blue pigment with yellow lead chromate or zinc chromate. There are other minor substitute blue colors and quite a group of greens, but the pigments containing ferrocyanide of iron are quite secure in their special fields of application. They are, however, frequently adulterated with various substances. Prussian blue has even been found on the market that contained a large admixture of starch stained blue with iodine. Inert fillers and extenders are, of course, commonly used not only to cheapen the cost but to give more body. Occasionally extraordinary amounts of such fillers are employed and the resultant mixture toned up with coal-tar colors.

PRODUCTION.

General.—No statistics of the world production of ferrocyanide blues have been found. It is, however, a large industry in Germany, France, and England. The domestic output in 1914 was 1,239,382 pounds, valued at $387,077.

Raw materials.—The raw materials essential to the making of Prussian blue and allied colors are (1) a soluble ferrocyanide and (2) an iron salt.

Yellow prussiate of potash was formerly the only important source of ferrocyanide, but during the war period the price of all potash salts rose to such levels that their use was practically prohibited in many industries. It was therefore necessary to use the sodium salt at most Prussian blue works in the United States. The latter salt, however, is not so well adapted to the preparation of the soluble blues. Calcium ferrocyanide recovered at gas works has also been used to a limited extent for the making of Prussian blue.[1]

The cheapest iron salt is copperas, and this is practically the only one used in color manufacture.

Process of manufacture.—Prussian blue can be made by either (1) the direct method or (2) by indirect methods. The former is merely the precipitation of the blue product by the addition of the ferrocyanide to a ferric salt, obtained by oxidation of a solution of copperas, ferrous sulphate, or by dissolving some ferric sulphate or chloride in water. The latter method, however, calls for the use of the ferrous salt (copperas), which must be free from all ferric iron, resulting in the precipitation of a pure white product (ferrous-ferrocyanide), which is oxidized to the final blue product by suitable agencies.

[1] Since copperas could not be used with a lime salt without contaminating the precipitate, the use of calcium ferrocyanide frequently calls for the preparation of the potash salt in solution, but the cost of crystallization is avoided.

Only a few Prussian blues are made by the direct process and these are much inferior in brightness to those made by the indirect method. The shade inclines to violet when in the wet state, and, although it changes on drying to a very full dark blue, it lacks brightness. Blues made by the direct process are generally known as "neutral blues" because they have not the fine metallic luster characteristic of pure Prussian blues made by the indirect process and which is demanded in the best grades. Hence, in spite of the apparent simplicity of the direct process, the indirect process is preferred in practice.

The first operation in the indirect process is the production of ferrous ferrocyanide ($Fe_2Fe(CN)_6$). If this intermediate product is oxidized to even the slightest degree until after it has been washed free from excess salts, the quality of the final blue will suffer. Extreme care is necessary, therefore, not only during the precipitation, but in the preparation of the precipitating solutions. The water employed for making up the solutions must be reasonably free from impurities and must be boiled in order to expel the air that may be dissolved in it. The prussiate and the copperas solutions are made up in separate tanks, clarified, and then run at a nearly boiling temperature into a third vat which is equipped with a mechanical stirring device. The copperas solution is added first. When all the iron solution is in the precipitation vat the ferrocyanide is added in a thin stream. Stirring is continued throughout the precipitation and for 15 minutes after the last of the prussiate has been run into the vat. The final temperature should not be less than 80° C. and is preferably higher than that. The precipitate is washed at least twice by decantation with hot water, and, up to this stage of the process, must be perfectly white and show no signs of oxidation. The water, even during the washing, and settling (a process that takes from two to four days) should at no time cool below 60° or 70° C.

After settling, the white precipitate must be formed into a stiff paste. This is done by filtering in baskets or presses or by evaporation. Evaporation is preferable, although of course more expensive, since it lessens the risk of oxidation. The stiff paste, however formed, is now ready to be oxidized to Prussian blue.

The method of oxidation varies according to the oxidizing agent used. The oldest method was to expose the material to the air. Later a mixture of sulphuric acid and nitric acid was employed. Both these methods have been practically discontinued, although the latter may be used at some small works. Bleaching powder is now the commonest oxidizing agent, but chlorates, nitrates, and even bichromates are occasionally used. The blued product is then washed, filtered, and dried.

Organization.—The manufacture of this extremely important group of colors is becoming more and more restricted to special blue works of the very largest color factories on account of the extensive plant required and because the process can be conducted profitably only on a large scale. Large tanks and settling apparatus are required, on account of the extreme fineness of the product, which settles very slowly. The filtering and washing operations are unusually slow and very troublesome. Even the pressing of the cake requires more care than does the same operation with other pigments. All these factors call for a large amount of space and a great number of tanks and accessory equipment in proportion to

the volume of the product. The raw materials, at least the prussiate, are very expensive. Because of the slow progress of the product through the plant, the interest charges on material in process of manufacture form a fairly large item. Considerable capital is necessary, therefore, not only for original plant but also for working capital.

Localities of production in the United States.—The census reports 15 establishments for the manufacture of Prussian blue in 1914. Six of these establishments were in New York, four were located in New Jersey (most of them near New York City), and four in Illinois. The location of the other establishment is not specified. The establishments located in the State of New York furnished 71 per cent of the value of the total domestic output in that year and, if the factories located in New Jersey are also assumed to lie in the New York district, nearly 95 per cent of the 1914 output was produced in the vicinity of New York.

Domestic production and consumption.—Prior to 1914 the domestic production furnished over 75 per cent of the total consumption of Prussian blue in the United States.

IMPORTS.

General.—Following the increase in the duty from 6 to 8 cents in the tariff act of 1897, the imports decreased steadily from over 212,000 pounds in 1897[1] to 132,000 in 1903. A short but rapid increase beginning in the next year brought the imports to 246,260 pounds in 1906.[2] After this record importation the annual imports fluctuated more or less, but ranged generally somewhat more than 190,000 pounds until the tariff act of 1913, when a marked increase is noted. The imports in 1915 were the largest in the history of the industry, amounting to 547,229 pounds, valued at $112,904. This value, however, was greatly exceeded in 1917, because of the enormous increase in prices of this product. The imports in that year amounted to 375,074 pounds, with a value of $209,524.

Countries.—The countries of origin of the imports of Prussian blue are not given in Commerce and Navigation. The only data at present available are for the year 1914.[3] These show that prior to the outbreak of the war Germany furnished practically all the imported supply. Only very small amounts were imported from England, France, Belgium, and Norway.

Revenue.—The maximum revenue collected on imports of ferrocyanide blues was $41,904.80. This amount was received in 1917 under the tariff act of 1913 (20 per cent ad valorem duty). Previous to 1915 the largest revenue was that collected in 1906, under the 8-cent duty of the act of 1897. The duties collected in that year amounted to $19,700, but the average revenue under the 8-cent duty was only about $15,000 annually.

PRICES.

There is little difference in price between the various shades of iron blues. The prewar average of these grades was a little less

[1] The references under this topic are to fiscal years.
[2] The declaration value per unit of quantity for that year was only $0.176, as compared with $0.224 in 1903 and $0.32 in 1894. In 1907 the value was $0.205.
[3] Department of Commerce, Miscellaneous Series No. 82.

than 30 cents per pound, with Prussian selling a trifle lower than Chinese, Milori, etc. Celestial blue, which is highly adulterated, was obtainable at around 5 cents. The war-time fluctuations, as shown on page 22, followed rather closely the price of ferrocyanide. At the midyear, 1919, the prices of these articles stand a little more than double prewar levels, all the iron blues, including Prussian, being quoted at 60 and 70 cents. Celestial increased 200 per cent and more, selling at 12 and 25 cents in July, 1919.

TARIFF HISTORY.

Prussian blue was first specifically mentioned in the tariff in the act of 1890, which provided for a specific duty of 6 cents per pound on this commodity. The same rate was continued in the act of 1894. In 1897 the rate was increased to 8 cents. As noted above, this increase had a very marked effect in reducing the amount of the imports. The duty on ferrocyanide blues was not changed in the act of 1909, but in 1913 these blues, in conformity with the tariff policy with respect to all pigments, were placed on an ad valorem basis. The rate of 20 per cent was equivalent to a reduction of more than 50 per cent in the protection, as for more than 10 years the declaration values of the imports had averaged less than 20 cents per pound. The effect on the quantities imported was almost instantaneous. The effect, however, during the later years of the war period was to largely increase the protection of the domestic manufacturer. During the fiscal year 1918 the average duty collected was 12.6 cents per pound.

COMPETITIVE CONDITIONS.

The most important feature of the competitive condition of the domestic Prussian-blue industry is the cost and availability of the prussiate supply necessary to the manufacture. It takes at least 120 pounds of yellow prussiate of potash to make 100 pounds of high-grade Prussian blue. The prewar price data indicate that in the United States the price of Prussian blue was from 50 to 75 per cent higher than that of this important raw material—a not very large margin. Prior to the war the potash salt was used almost exclusively as the raw material. Since the United States was dependent upon Germany for some 50 per cent of its consumption of yellow prussiate of potash, which was imported over a tariff barrier of 2 cents per pound in the act of 1913, it is evident that the American manufacturer was at a decided disadvantage.

The war wrought a marked change in the situation, due to the extended use of prussiate of soda in place of the potash salt. The price of the latter rose from about 13 cents in 1914 to $1.80 in 1916, and later dropped to a little more than $1 per pound. These prices made the cost of the potash salt practically prohibitive for color manufacture. Attention was therefore directed toward the use of the sodium compound, which before the war had been selling at less than 10 cents per pound. It had not been used in color manufacture to any large extent, probably because it could not be secured in as pure condition as the more easily purified potash salt. The theoretical quantity required to make 100 pounds

of product is somewhat less than in the case of prussiate of potash, but apparently, in spite of the lower cost of raw material, it was not profitable for the manufacturer to use the soda salt until the differential was increased to an enormous extent.

The position of the domestic producer with reference to supplies of the sodium salt is much better than in the case of the potash compound. During the war period it is probable also that considerable progress was made in cheapening the domestic supplies of all compounds containing fixed nitrogen, including both the prussiates, as compared to the former relative costs in this country and in Europe. It is doubtful, however, if domestic blue manufacturers can meet foreign competition on equal terms.

Prussian blue—Production in United States.

[From Federal Census.]

Year.	Quantity.	Value.
	Pounds.	
1899	(1)	
1904	(1)	
1909	(1)	
1914	1,239,382	$387,077

[1] 1899, 1904, 1909 the pigments lithopone, chrome yellow, orange or green, Prussian blue, ultramarine and other dry colors were grouped into one class.

Blues, such as Berlin, Prussian, Chinese, and all others containing ferrocyanide of iron—Imports for consumption—Revenue.

IN PULP, DRY OR GROUND IN OR MIXED WITH OIL OR WATER.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Calendar year:		*Pounds.*				*Per cent.*
1911	8 cents per pound.	167,002	$29,482	$13,360	$0.177	45.3
1912	do.	172,905	31,229	13,832	.180	44.2
1913		221,827	40,917	14,561	.184	35.70
1914	20 per cent.	380.573	73,077	14,615	.192	20.00
1915	do.	409,543	102,504	20,501	.25	20.00
1916	do.	447,362	281,850	56,366	.628	20.00
1917	do.	23,892	17,999	3,600	.752	20.00
1918	do.	2,923	3,100	620	1.06	20.00
1919	do.	16,055	5,862	1.172	.365	20.00
1920 [1]	do.	286,830	118,046	23,609	.425	20.00

IN PULP, DRY OR GROUND IN OR MIXED WITH WATER.[2]

Fiscal year:						
1908	8 cents per pound.	197,505	$41,706	$15,800	$0.211	37.88
1909	do.	188,104	39,008	15,048	.207	38.58
1910	do.	206,539	37,360	16,523	.181	44.23
1911	do.	189,681	34,804	15,174	.184	43.60
1912	do.	137,999	24,606	11,039	.178	44.87
1913	do.	193,336	34,476	15,466	.178	44.86
1914 [3]	do.	50,157	9,599	4,012	.191	41.80
1914 [4]	20 per cent.	225,017	40,550	8,110	.180	20.00
1915	do.	547,299	112,904	22,580	.206	20.00
1916	do.	185.294	110,901	22,180	.599	20.00
1916 [5]	20 per cent less 20 per cent.	77	90	14	1.17	16.00
1917	20 per cent.	373,074	209,524	41,904	.562	20.00
1918	do.	23,867	15,009	3,001	.629	20.00
1919	do.	8,222	5,979	1,196	.727	20.00

[1] Six months ending June 30, 1920.
[2] "Mixed with oil or water," under act of 1913.
[3] Act of 1909—July 1, 1913, to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913, to June 30, 1914.
[5] From Cuba (reciprocity treaty, Dec. 27, 1903)

Blues—Dry colors, prices (wholesale or retail) per pound, 500-pound lots.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919
Prussian:								
January..	$0.28–$0.30	$0.28–$0.30	$0.30–$0.31	$0.46–$0.48	$1.50	$1.00–$1.75	$0.67–$1.50	$1.10–$1.15
April.....	.28– .30	.30– .31	.27– .28	.46– .48	$2.00– 2.25	.85– 1.50	.70– .90	.80– .90
July.....	.28– .30	.30– .31	.27– .28	.95– 1.05	1.80– 2.25	.80– 1.50	1.35– 1.50	.60– .70
October..	.28– .30	.30– .31	.46– .48	1.10– 1.15	1.30– 1.80	.80– 1.50	1.35– 1.40	.65– .75
Celestial:								
January..	.04– .06	.04– .06	.04– .06	(1)	.18– .20	.20– .30	.15– .25	.15– .25
April.....	.04– .06	.04– .06	.04– .06	(1)	.22– .25	.20– .30	.15– .25	.12– .25
July.....	.04– .06	.04– .06	.04– .06	.18– .20	.20– .30	.20– .30	.15– .25	.12– .25
October..	.04– .06	.04– .06	(1)	.18– .20	.20– .30	.20– .30	.15– .25	.12– .25
Chinese:								
January..	.30– .31	.29– .32	.30– .32	(1)	(1)	1.50– 1.80	.70– 1.50	1.10– 1.15
April.....	.30– .31	.30– .32	.30– .32	(1)	2.00– 2.25	.85– 1.50	.73– .95	.80– .90
July.....	.30– .31	.30– .32	.30– .32	(1)	1.80– 2.50	.85– 1.50	1.35– 1.50	.60– .70
October..	.30– .31	.30– .32	(1)	(1)	1.50– 1.80	.85– 1.50	1.35– 1.40	.65– .75
Milori:								
January..	.30– .31	.29– .32	.30– .32	(1)	(1)	(1)	.70– .85	1.10– 1.15
April.....	.30– .31	.30– .32	.30– .32	(1)	(1)	(1)	.73– .85	.80– .90
July.....	.30– .31	.30– .32	.30– .32	(1)	(1)	(1)	1.35– 1.50	.60– .70
October..	.30– .31	.30– .32	(1)	(1)	(1)	(1)	1.35– 1.40	.65– .75

[1] Nominal.

Blues—Dry colors, prices (wholesale or retail) per pound.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919
Soluble, 250-pound lots:								
January..	$0.30–$0.31	$0.30–$0.32	$0.30 –$0.32	$0.50 –$0.55	$1.50	$1.50–$2.00	$0.72–$1.50	$1.13–$1.18
April.....	.30– .31	.30– .32	.28 – .30	.50 – .55	2.25	1.50– 2.00	.82– .95	.85– .95
July.....	.30– .31	.30– .32	.28 – .30	.85 – .90	$1.80– 2.25	1.50– 2.00	1.35– 1.50	.65– .75
October..	.30– .31	.30– .32	.27 – .29	1.15 – 1.25	1.50– 2.00	.85– 1.50	1.35– 1.50	.68– .78
Ultramarine, in barrels:								
January..	.05– .15	.04– .13	.04 – .13	.03½– .13	.05– .22	.20– .40	.17– .50	.14– .40
April.....	.05– .15	.04– .13	.03½– .13	.03½– .13	.07– .30	.20– .40	.17– .50	.08– .40
July.....	.05– .15	.04– .13	.03½– .13	.04 – .22	.10– .40	.25– .40	.17– .50	.12– .40
October..	.05– .15	.04– .13	.03½– .13	.04 – .22	.17– .40	.17– .50	.14– .50	.12– .40
Italian:								
January..	.18– .25	.16– .12	.16 – .22	(1)	(1)	(1)	.78	.....
April.....	.18– .25	.16– .12	.16 – .22	(1)	(1)	(1)	.78	.....
July.....	.18– .25	.16– .22	.16 – .22	(1)	(1)	(1)	.....	.....
October..	.18– .25	.16– .22	(1)	(1)	(1)	(1)	.....	.....
Prussian, foreign:								
January..	.32– .36	.32– .36	.32 – .36	.....	.....	.....	.....	(1)
April.....	.32– .36	.32– .36	.32 – .36	.....	.....	.....	(1)	(1)
July.....	.32– .36	.32– .36	.32 – .36	.....	.....	.....	(1)	(1)
October..	.32– .36	.32– .36	.48 – .50	.....	.....	.....	(1)	.....
Bronze, 500-pound lots:								
January..	.....	.....	.....	.46 – .48	(1)	1.00– 1.75	.70– 1.50	1.10– 1.15
April.....	.....	.....	.....	.....	.....	.....	.....	.80– .90
July.....	.....	.....	.....	.....	.....	.....	1.35– 1.50	.60– .70
October..	.....	.....	.....	.....	.....	.....	1.35– 1.40	.65– .75

[1] Nominal..

Blues, in oil, prices (wholesale or retail) per pound, in 1-pound and 5-pound cans.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916
Chinese:					
January	$0.36–$0.46	$0.36–$0.46	$0.36–$0.46	$0.36–$0.46	$1.50–$1.60
April	.36– .46	.36– .46	.36– .46	.36– .46	2.35
July	.36– .46	.36– .46	.36– .46	.70– .80	1.80– 2.00
October	.36– .46	.36– .46	.36– .46	.70– .80	1.50– 1.75
Prussian:					
January	.32– .36	.32– .36	.32– .36	.32– .36	1.60– 1.70
April	.32– .36	.32– .36	.32– .36	.32– .36	2.25
July	.32– .36	.32– .36	.32– .36	.64– .70	1.80– 2.00
October	.32– .36	.32– .36	.32– .36	.64– .70	1.45– 1.70
Ultramarine:					
January	.13– .16	.13– .16	.13– .16	.13– .16	.15– .20
April	.13– .16	.13– .16	.13– .16	.13– .16	.30– .50
July	.13– .16	.13– .16	.13– .16	.15– .20	.30– .50
October	.13– .16	.13– .16	.13– .16	.15– .20	.40– .50

Kind or grade.	1917	1918	1919	1920
Chinese:				
January	$1.50–$1.75	$1.30–$1.60	$1.30–$1.60	$1.00–$1.10
April	1.50– 1.75	1.30– 1.60	1.10– 1.30	1.00– 1.10
July	1.50– 1.75	1.30– 1.60	1.00– 1.10	1.00– 1.10
October	1.50– 1.75	1.30– 1.60	1.00– 1.10	1.00– 1.10
Prussian:				
January	1.45– 1.70	1.20– 1.50	1.20– 1.50	1.00– 1.10
April	1.45– 1.70	1.20– 1.50	1.10– 1.30	1.00– 1.10
July	1.45– 1.70	1.20– 1.50	1.00– 1.10	1.00– 1.10
October	1.45– 1.75	1.20– 1.50	1.00– 1.10	1.00– 1.10
Ultramarine:				
January	.40– .50	.40– .50	.45– .60	.40– .50
April	.40– .50	.40– .50	.45– .60	.40– .50
July	.40– .50	.45– .60	.40– .50	.40– .50
October	.40– .50	.45– .60	.40– .50	.40– .50
Imitation cobalt:[1]				
January	.....	.50– .65	.50– .65	.45– .60
April	.....	.50– .65	.50– .65	.45– .60
July	.....	.50– .65	.45– .60	.45– .60
October	.....	.50– .65	.45– .60	.45– .60

[1] Not quoted prior to 1918.

Blues, dry colors—Prices (wholesale or retail) per pound, 500-pound lots (1920).

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	Prussian.	Celestial.	Chinese.	Milori.	Soluble (250-pound lots).	Ultramarine (barrels).	Bronze (tin).
January	$0.80–$0.85	$0.12–$0.25	$0.80–$0.85	$0.80–$0.85	$0.85–$0.90	$0.35–$0.50	$0.80–$0.85
April	.90	.12– .25	.90	.90	.90	.15– .50	.90
July	.90– 1.00	.12– .25	.90– 1.00	.90– 1.00	.90– 1.00	.15– .50	.90– 1.00
October	.95– 1.00	.12– .25	.95– 1.00	.95– 1.00	1.00– 1.05	.15– .50	.95– 1.00

Prussian blue—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Colors and paints, including lakes, whether dry or mixed, or ground with water or oil, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	50	Blues, such as Berlin, Prussian, Chinese, and all others containing ferrocyanide of iron, dry, or ground in or mixed with oil. In pulp or mixed with water 6 cents per pound on the material contained therein when dry.	6 cents per pound.
1894	38	Same as above	Do.
1897	45	Blues, such as Berlin, Prussian, Chinese, and all others, containing ferrocyanide of iron, in pulp, dry or ground in or mixed with oil or water.	8 cents per pound.
1909	43	Same as above	Do.
1913	52	.....do	20 per cent ad valorem.

ULTRAMARINE BLUE AND WASH BLUE.

[Par. 52, act of 1913, 15% ad valorem.]

SUMMARY.

Ultramarine is the most important blue pigment. The commercial product is manufactured in a variety of grades, all having similar chemical composition and difficult to distinguish by laboratory investigation. A practical application to the purpose for which it is sold seems to be the only criterion of value since the properties depend upon the mechanical preparation of the product. Ultramarine is used not only for painting and in printer's inks, but also for coloring soaps and laundry blue. It is also used in small quantities to neutralize the yellow color in paper pulp. Green, yellow, violet, and red varieties of ultramarine are manufactured, but none of the colors, except blue, are consumed in any but small quantities.

The chief raw materials required in the manufacture of ultramarine are soda ash (sodium carbonate), China clay, carbon, and sulphur. There is also a method of manufacture in which Glauber's salt is substituted for the soda ash and sulphur. The fuel requirements are fairly large. Domestic manufacturers are not handicapped as regards their supply of raw materials or fuel. Extremely pure materials are necessary, but these can be obtained as cheaply in this country as in most foreign countries. Labor, however, is a much more important item of cost in the manufacture of ultramarine than it is in the case of most pigments.

The domestic output is furnished largely by one producer, although there are several smaller establishments, and in 1914 about one-fourth of the total domestic consumption was imported. Prior to the war imports were derived chiefly from England and Germany. Other European countries have furnished only a small fraction of the foreign ultramarine sold in the domestic market.

Ultramarine summary table.[1]

	Domestic production.	Imports for consumption.	Ratio of imports to production.
Calendar year:	*Pounds.*	*Pounds.*	*Per cent.*
1911	.....	740,479	.....
1912	.....	802,376	.....
1913	.....	701,033	.....
1914	2,698,639	876,688	32.48
1915	.....	394,202	.....
1916	.....	411,334	.....
1917	.....	389,053	.....
1918	.....	287,520	.....
1919	.....	310,165	.....
1920[2]	.....	235,887	.....

[1] Not including wash blue.

[2] Six months ending June 30, 1920.

Ultramarine summary table—Continued.

	Value (imports for consumption).	Amount of duty.	Value per unit.	Equivalent ad valorem rate.
Calendar year:				*Per cent.*
1911	$67,082	$22,214.37	$0.0907	33.0
1912	70,190	24,071.28	.0875	34.3
1913	63,853	17,455.20	.0913	27.4
1914	78,212	11,731.80	.0893	15.0
1915	37,661	5,649.15	.0956	15.0
1916	49,921	7,488.15	.1220	15.0
1917	32,362	4,854.30	.0833	15.0
1918	29,490	4,423.00	.102	15.0
1919	38,968	5,845.00	.145	15.0
1920[1]	19,954	2,993.00	.084	15.0

[1] Six months ending June 30, 1920.

General Information.

Paragraph 52, of the act of 1913.—"* * * ultramarine blue, whether dry, in pulp, or ground in or mixed with oil or water, and wash blue containing ultramarine, 15 per cent ad valorem."

DESCRIPTION.

Ultramarine is the most important blue pigment.[1] It occurs in nature as the mineral lapis lazuli. But the natural mineral is very rare, being classed with the semiprecious stones, and is of no importance as a pigment. The ultramarine of commerce is an artificial product of the same composition as the natural mineral and is sold in the form of a bright azure-blue impalpable powder that is not soluble in water.

Chemically, ultramarine is a double silicate of sodium and aluminum and containing a little sulphide. Different samples of the same physical qualities, however, often differ slightly in composition. A pure white ultramarine is supposed to be the base of the whole series of colored compounds. Its formula is given as $Na_2Al_2SiO_8.Na_2S$. The common blue variety is believed to vary from a soda ultramarine, poor in silicia—$4(Na_2Al_2Si_2O_8).Na_2S_4$—to a modification containing high silica—$2(Na_2Al_2Si_3O_{10}).Na_2S_4$. Green ultramarine is probably not a distinct chemical compound but a mixture of other ultramarines.

Yellow, violet, and red varieties of ultramarine have been produced, and green ultramarine is an intermediate product in the manufacture of blue ultramarine according to one method. None of these, except the green, have any commercial importance, as they have little tinctorial power and are generally more expensive than better pigments of like shade but having a different composition.

USES.

Ultramarine blue is much used in wall paper for neutralizing the yellow in paper pulp and cotton and linen goods, for laundry blue (bluing), for coloring mottled soaps, and as a general pigment in lithographic ink and in paint. Only the better grades are used in

[1] Thorp. Outlines of industrial chemistry. Macmillan. 1916.

artists' colors, coach and car colors, and in printing. Sand colored by ultramarine is sometimes used as an imitation for smalt—a potash-cobalt glass.

SUBSTITUTES.

Ultramarine has largely replaced most of the cobalt colors in painting and can be used with zinc white as a tint. Prussian blue, however, is generally preferable and is always employed as the blue constituent of greens obtained by mixing blue and yellow pigments. These two colors, ultramarine and Prussian (and other ferrocyanide) blue, are now practically the only commonly used inorganic blue pigments. There is a growing use of lakes, but these organic (largely coal-tar) colors are generally less permanent. The choice between ultramarine and ferrocyanide colors depends upon whether or not resistance to alkalies is required. Both are permanent to light when used alone and are obtainable at about the same range of prices and grades. Ultramarine is not affected by alkalies, but is affected by (or, perhaps more properly, does affect) lead compounds. The ferrocyanide colors are destroyed by alkalies (cf. soaps), do not react with lead compounds, and are a trifle less resistant even than ultramarine to acids. Neither pigment, however, is satisfactory when exposed to acid fumes.

PRODUCTION.

General.—The annual world production of ultramarine (in 1913) was from 10,000 to 15,000 tons, valued (on an average) at something less than $150 per ton. There are at least 100 factories, mainly in Germany and France, although a few are in England, Austria, and the United States. The development of this pigment has been remarkable. The process for making the artificial variety was discovered in 1828. When first placed on the market, the price was 16s. (about $3.90) per pound. But later, competition resulted in a quite rapid reduction, both in price and in cost of manufacture. Factories were established in Cologne and Nuremburg between 1830 and 1840, and from 9 to 12 new factories appeared in various parts of Europe in every succeeding decade.[1]

Raw materials.—The materials used in making ultramarines are China clay or other high-grade pottery clay, soda ash (carbonate), or Glauber's salt (sodium sulphate), carbon (charcoal, lampblack, etc.), sulphur, and sometimes kieselguhr, diatomaceous earth, or other silicious matter. All materials entering into the manufacture of ultramarine must be selected with care. High purity is essential for making a product of suitable color. Iron, especially, is likely to make the product dull; hence the clay must be carefully washed and only grades of soda that contain no iron salts can be used. When sodium sulphate is employed, it must not contain free acid.

Process of manufacture.—Ultamarine may be manufactured by either of two processes, (1) the direct method which uses soda ash, or (2) the indirect method in which the requisite soda is supplied by Glauber's salt. Both processes involve furnace treatment.

[1] Data in this paragraph from Thorpe's Dictionary of Applied Chemistry.

(1) *The direct process* yields blue ultramarine as the first product, but is extremely slow. The fusion is conducted in muffles or crucibles. The former are generally more economical, although their slow cooling—taking 10 to 12 days—somewhat adds to the time of the process. Three or four weeks are required for the treatment of a single charge in one of these muffles, which generally takes about 2½ tons per charge. Smaller quantities are handled in crucibles, and the extra labor involved, together with the breakage, more than offsets the less time required in heating and cooling off.

The raw materials, consisting of soda ash, clay, charcoal, and sulphur, are mixed in proper proportions and finely ground. They are charged into a cold furnace and packed firmly into crucibles or tamped down on the floor of a muffle in a layer about 14 inches thick. Before heating, the charge must be covered up and luted air-tight. Access of air at any time until after the reactions are completed and the furnace is cool will ruin the product. During the heating process, the chief operation aside from firing the furnace is the covering up of cracks, etc., in order to prevent the entrance of air.

At the conclusion of the fusion and after the furnace is cool, the charge is found to be in two layers, the top bright blue and the bottom greenish blue. These are separated, washed, ground, and levigated. The washing removes soluble salts. Because of the considerable amount of water glass (sodium silicate) which must be removed, soft water must be used in washing and grinding operations. The pulp, after grinding, is run into settling vats, where it settles according to the varying degree of fineness. The very highest qualities require several days to settle out from the water. The levigation is a most important stage of the process and requires great care and attention. The bulk of the blue settles out in from 36 to 48 hours, but it must then be shoveled out and resettled. As each batch is slightly different from the preceding, blending is a necessary adjunct to the production of standard shades.

(2) *The indirect process* yields green ultramarine as the first product and is a much quicker process than the direct method. The first fusion differs from the direct operation chiefly in that soda ash and sulphur are replaced by sodium sulphate. The sulphate requires a little more coal or charcoal in the charge (as it must be reduced to sulphide in the fusion). Rosin is sometimes used as a reducing agent.

The heating, which is generally conducted in crucibles, takes about eight hours, but the slow cooling of the furnace adds several hours more to the treatment period. After cooling, the mass is green and porous. It needs only to be washed free from impurities and ground for sale as ultramarine green.

To make blue ultramarine, the green powder is roasted with sulphur. The heating is done in open pans or muffles and the charge is stirred mechanically. It is probable that a part of the sodium sulphide is oxidized to soluble sulphate during the heating and thereby removed from the combination with the silicates. The extent of this change is regulated by adding sulphur from time to time. The cooled blue product is ground and levigated.

In making the cheaper brands of ultramarine blue, the pure color is mixed with gypsum. This adulterant is sometimes added in amounts up to 50 per cent. It has an extremely bad effect on the

brightness of the color of certain varieties of ultramarine, but the effect is minimized by the addition of a little glycerol or vaseline to the mixture.

Equipment.—In addition to the usual equipment for grinding and mixing raw materials and for the preparation of the finished pigment considerable furnace area would seem to be required for the making of ultramarine. The furnaces, however, are of simple construction and can be made of local brick.

DOMESTIC PRODUCTION.

The census figures show an output of 2,698,639 pounds of ultramarine, valued at $222,769, in 1914.

IMPORTS.

Quantity.—The imports of ultramarine in the fiscal year 1914 were the largest on record, amounting to 901,203 pounds, valued at $78,392. It is worthy of note that the imports of ultramarine from July to September, 1913, under the act of 1909 were about equivalent in volume to the imports in the nine months of the fiscal year 1913 under the act of 1913. About 40 per cent of the revenue collected during the year, however, was obtained from the imports during the first three months under the act of 1909.

The average annual importation of ultramarine for the eight preceding years (1906–1913, inclusive) was approximately 700,000 pounds, valued at $63,438. Throughout this period the variation in the amount and value of the imports from year to year is noticeably small; but in 1906, the first year of the period, there was a sharp increase, amounting to over 50 per cent, as compared to the preceding year and similarly, as compared with the average yearly imports for the 10-year period, 1896 to 1905. That decade is also remarkable for the slight yearly variations from the general average importations—416,651 pounds, valued at $45,950, annually—for these years. It is a coincidence that this period, like the one that succeeded it, was ushered in by a radical fluctuation in the amount and value imported. The change in this instance, however, was a reduction. The imports in 1896 were almost 50 per cent less than the imports in 1905.[1]

Since the outbreak of the European war the imports of ultramarine have decreased gradually. In 1918 (fiscal year) less than 360,000 pounds were imported.

Wash blue, containing ultramarine, is listed separately in Commerce and navigation. The imports are small in amount and register a gradual decrease both in quantity and value until 1914. Less than 100,000 pounds were imported in 1913. Since October 3, 1914, when an ad valorem duty was adopted, the quantities of wash blue imported have not been published by the Department of Commerce. The values, however, show a rapid decrease from 1914 to 1916 in

[1] The fiscal year 1895, however, was a year of abnormal imports, following immediately after the reduction in the duty on Aug. 28, 1894.

spite of the lowered rate of duty. But in 1917 imports of wash blue were valued at $25,280, the highest value recorded since 1906. This increase, however, was due rather to greatly enhanced prices than to any large increase in the quantity.

Countries of origin.—The imports by countries of ultramarine and of wash blue containing ultramarine are not published in Commerce and Navigation. A compilation made by the Department of Commerce,[1] however, shows that in the fiscal year 1914, the last year before the outbreak of the European war, Germany and Great Britain furnished by far the greater part of the imports. In the case of ultramarine, 51.2 per cent of the imports were derived from England, 42.9 per cent from Germany, 2.5 per cent from Belgium, 2.4 per cent from France, 0.7 per cent from the Netherlands, and 0.3 per cent from Scotland. Of the wash blue imported in that year, 51.6 per cent came from Germany, 34.8 per cent from England, 10 per cent from France, and 3.6 per cent from Belgium.

Character.—The following statement is quoted from a brief prepared by Mr. F. A. Reichard and published in tariff hearings, House of Representatives, Sixtieth Congress (1909), page 459:

> The bulk of what is sold here is made in the United States and is sold from 3½ to 10 cents per pound. There are better grades used for artists' colors, for printing purposes, coach and car colors, and in the manufacture of sugar, etc. These are the only grades that can be imported. * * *

Referring to page 9, it will be noted that the value per unit of quantity of the imports of ultramarine has rarely exceeded 10 cents per pound and has generally been only a little less.

> We do not import ultramarine blue for the reason that our trade is principally with paint manufacturers who use mostly cheap or medium grades, selling from 3½ to 10 cents per pound, and with a duty of 3¾ cents per pound (more than the actual selling price of the lower grades) it does not require much acumen to see that the present duty is prohibitive.

PRICES.

There is a considerable spread between the high and the low prices of ultramarine, due to the great difference in quality of the various grades. The prewar price (1914) ranged from 3½ to 13 cents per pound for the dry pigment and 13 to 16 cents per pound in oil. The outbreak of the war had little immediate effect, as it was not until late in 1915 that the quotations for this pigment showed any marked increase; but during 1916 the price rose rapidly, due to the greatly increased cost of raw materials, especially soda ash. The increase was greatest in the case of the lower grades, which were quoted in January, 1917, at 20 cents. After the signing of the armistice there was only a slight recession. Quotations in January, 1919, were 14 to 40 cents for dry and 50 to 65 for ultramarine in oil, while in June the quotations were 12 to 40 and 40 to 50, respectively.

TARIFF HISTORY.

The rate of duty on ultramarine blue has been gradually reduced from 5 cents per pound (about 50 per cent ad valorem) in 1883 to 15 per cent (roughly 1.5 cents per pound on the type of material imported) ad valorem in the act of 1913. The only upward movement

[1] Department of Commerce, Miscellaneous Series No. 82.

was in the act of 1897, when the duty which had been reduced from 4½ to 3 cents per pound in the act of 1894, was increased to 3¾ cents. But in 1909 it was scaled back to 3 cents and in the act of 1913 it was practically cut in half.

The 1913 act also introduced a radical change in the form of an ad valorem instead of the specific duties that had hitherto been adopted.

SPECIFIC VERSUS AD VALOREM DUTIES.

In the various briefs presented in tariff hearings in 1909 and 1913, both manufacturers and importers [1] devoted considerable space to an insistence upon specific duties on this article. It was alleged that the proper appraisal of imports of ultramarine was peculiarly difficult, because of the great number of different grades which can not be distinguished except by an expert. It is claimed that the more expensive varieties do not differ materially in general appearance or chemical composition from the cheaper grades.

The general sentiment is expressed in the following petition, which was presented by Badische Co. and others in tariff hearings (H. R., 63d Cong., 1913, pp. 144–145):

> The characteristics which give ultramarine blue its value are the results of its mechanical preparation and are quite independent of its chemical composition. Its value is not readily established by a laboratory investigation; a practical application to the purpose for which it is sold alone determines its value.
>
> Prior to the year 1870 there was an ad valorem duty on ultramarine blue, but the appraisal of the imports caused so much confusion and acrimonious discussion that the rate, at the request of all concerned, was changed to a specific one and has remained so ever since.
>
> We, the undersigned, importers, respectfully petition, therefore, that the duty on ultramarine blue be made specific and not ad valorem.

COMPETITIVE CONDITIONS.

The manufacture of ultramarine in the United States is not handicapped in any way as regards its supply of raw material. Soda salts and sulphur are at least as cheap in this country as anywhere else in the world and are in ample supply. Since it is a furnace operation, the domestic industry also has certain advantages as regards fuel supply. The one handicap, apparently, is the greater cost of labor in this country, and the item of labor forms a larger fraction of the total cost of the finished product in the case of ultramarine than it does in the case of most of the products of the pigment trade.

In this connection the following statements in tariff hearings should receive attention:

TARIFF HEARINGS.

A canvass of paint grinders (consumers) made prior to the tariff act of 1909, elicited 48 replies; 7 favored free entry, 2 favored a specific duty of 2 cents per pound, 2 favored a duty of 3¾ cents per pound (existing duty under the act of 1897), 1 favored a specific duty of 1 cent per pound, 1 favored 12 per cent ad valorem, and 34 asked for an ad valorem duty of 20 per cent. The extraordinary agreement is explained by the fact that the 20 per cent rate was suggested by Mr. F. A. Reichard who conducted the canvass. It will be noted

[1] But see argument of F. A. Reichard below.

that of those that actually suggested a different duty, only one chose an ad valorem duty.

In another brief, Mr. Reichard claimed that the manufacture of ultramarine in the United States is in the hands of a trust, submitting as evidence the full transcript of the testimony under T. D. 28294, G. A. 6636. In this case it was shown clearly that the domestic production in 1907 was controlled or largely controlled by three firms, viz: Heller & Merz, the Ultramarine Co., and, the International Ultramarine Works—all of which are related. Mr. Reichard believed that this "trust" was protected to a greater extent than it was entitled to and that "the duty on low and medium grades is prohibitive." He urged a reduction in the duty so as to permit the importation of ultramarine and "break the monopoly enjoyed by the Ultramarine Trust." His final statement is, "A specific duty seems impracticable, owing to the great number of different grades of the article."

Messrs. Heller & Merz (Tariff Hearings, 1913) request that no change be made in the specific duty of 3 cents per pound (under the act of 1909) and especially urge that the duty be specific and not ad valorem because of the wide variety of specialties and prices and the attendant difficulty of appraisement. They further cite the fact that the imports of ultramarine increased 250 per cent in a period of 13 years (1898 to 1911). No reference, however, was made to the fact the imports in 1911 (685,933 pounds) was less than the imports in the year 1895 (818,830 pounds) when the duty was 3 cents per pound and not much greater than in 1894 when 646,170 pounds of ultramarine were imported even with a duty of 4½ cents per pound. The following data as regards cost, however, are of interest:

"Our unskilled and semiskilled labor is paid from $10 to $15 per week. Skilled labor is paid from $3 to $4 per day, or from $18 to $24 per week.

"German laborers in ultramarine factories are paid but 50 per cent of the American wages. French laborers in ultramarine factories are paid 63 cents per day or 37 per cent of the lowest American wages. Belgian laborers in ultramarine factories are paid 43 cents per day, or 25 per cent of the American wages.

"The duty levied on ultramarine under the German tariff law, though but 15 marks per 100 kilos, is prohibitive * * *. Official statistics show that the German imports are less than 1½ per cent of the German production of ultramarine. The French manufacturer has the benefit of a protective duty of 30 francs per 100 kilos, or 2¾ cents per pound (?)."

The Standard Ultramarine Co. state that the item of labor bears 50 per cent of the cost of manufacture and that "our wage scale" is "at least four times greater than the same class of labor in some foreign plants manufacturing this article." This brief also emphasizes the difficulty of appraisal and the desirability of a specific rather than an ad valorem duty. A duty of not less than 2½ cents per pound is advocated as not working a hardship and at the same time placing the domestic manufacturer on a competitive basis with foreign manufacturers.

Ultramarine—Production in United States—"Official source."

[Figures from "Federal Census."]

In years 1899, 1904, and 1909 the production is included with other pigments prior to 1914; in 1914 the production was 2,698,639 pounds, valued at $222,769.

Ultramarine, dry in pulp or mixed with water [1]—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1910	3½ cents per pound.	18,630	$1,879	$706	$0.100	37.58
1910	3 cents per pound.	690,896	64,322	20,726	.093	32.22
1911	.....do.....	685,933	63,817	20,577	.093	32.25
1912	.....do.....	745,091	66,435	22,352	.089	33.65
1913	.....do.....	694,938	62,259	20,848	.089	33.48
1914	.....do.....	199,315	17,051	5,979	.086	35.07
1914	15 per cent.....	701,888	61,341	9,201	.087	15.00
1915	.....do.....	641,381	62,715	9,407	.098	15.00
1916	.....do.....	401,605	44,709	6,706	.111	15.00
1917	.....do.....	388,201	36,433	5,464	.099	15.00
1918	.....do.....	359,136	35,210	5,281	.098	15.00
1919	.....do.....	197,578	25,991	3,879	.131	15.00
Calendar year:						
1918	.....do.....	287,520	29,490	4,423	.102	15.00
1919	.....do.....	318,165	38,968	5,845	.125	15.00
1920 [2]	.....do.....	235,887	19,954	2,993	.084	15.00

[1] "Mixed with oil or water" under act of 1913. [2] Six months ending June 30, 1920.

Wash blue, containing ultramarine—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year.		*Pounds.*				*Per cent.*
1910	3½ cents per pound.	39,616	$4,358	$1,485	$0.110	34.09
1910	3 cents per pound.	73,329	10,364	2,199	.141	21.23
1911	.....do.....	129,800	13,786	3,894	.106	28.25
1912	.....do.....	112,234	14,269	3,367	.127	23.59
1913	.....do.....	97,220	13,332	2,916	.137	21.88
1914	.....do.....	15,375	1,815	461	.118	25.41
1914	15 per cent.....	.....	11,090	1,663	.....	15.00
1915	.....do.....	.....	6,485	972	.....	15.00
1916	.....do.....	.....	4,907	736	.....	15.00
1917	.....do.....	.....	25,280	3,792	.....	15.00
1918	.....do.....	.....	15,686	2,352	.....	15.00
1919	.....do.....	53,703	11,261	1,689	.210	15.00
Calendar year:						
1918	.....do.....	.....	11,841	1,776	.....	15.00
1919	.....do.....	61,282	13,178	1,976	.215	15.00
1920 [1]	.....do.....	99,300	14,856	2,228	.149	15.00

[1] Six months ending June 30, 1920.

Ultramarine—Prices (wholesale) per pound, in barrels, spot, New York.

[Data from Oil, Paint, and Drug Reporter.]

	Dry.	In oil.		Dry.	In oil.
	Cents.	*Cents.*		*Cents.*	*Cents.*
August, 1914	3½–13	13–16	June, 1919	12–40	40–50
January, 1915	3½–13	13–16	October, 1919	12–40	40–50
January, 1916	5 –22	15–20	January, 1920	35–50	40–50
January, 1917	20 –40	40–50	April, 1920	15–50	40–50
January, 1918	17 –50	50–65	July, 1920	15–50	40–50
January, 1919	14 –40	50–65	October, 1920	15–50	40–50
April, 1919	12 –50	45–60			

Ultramarine blue and wash blue (containing ultramarine)—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Ultramarine	5 cents per pound.
		Polishing powders of every description, by whatever name known, including Frankfort black, and Berlin, Chinese, fig, and wash blue.	20 per cent ad valorem.
1890	55	Ultramarine blue	4½ cents per pound.
	58	Wash blue containing ultramarine	3 cents per pound.
1894	43	Ultramarine blue, whether dry, in pulp, or mixed with water, and wash blue containing ultramarine.	Do.
1897	52	Same as act of 1890	3¾ cents per pound.
1909	50	....do	3 cents per pound.
1913	52	* * * ultramarine blue, whether dry, in pulp, or ground in or mixed with oil or water, and wash blue containing ultramarine.	15 per cent ad valorem.

MISCELLANEOUS.

AZURE BLUE.

This pigment is classified as a pigment not otherwise provided for, but as it is a by-product of ultramarine and has caused some difficulty on appraisal (v., p. 13) the following statement of Mr. F. A. Reichard is presented herewith:

> Azure gray blue is imported exclusively by us, no other concern bringing it into the United States, so far as we are aware of. The business in it is new and, as yet, very small, indeed. The price at which it is sold here is about 3 cents per pound, and the injustice of assessing it at the same rate of duty as that charged on goods selling as high as 10 cents and over is apparent.
>
> Azure gray blue is not an ultramarine blue, and is not known commercially as such; it is simply a by-product of the manufacture of ultramarine blue and is not used for any of the purposes for which ultramarine is ordinarily used.

The only data as to the imports of this commodity are those published by the Department of Commerce.[1] These cover the imports during the fiscal year 1914 and include the following items:

Country.	Pounds.	Value.
Germany	1,685	$65
Do	979	219
France	22	22

Ultramarine blue.—The merchandise in issue was held not to be ultramarine blue, but a substitute for ultramarine blue sold to the paper and paint trade.—United States *v.* Riebe, 1 Ct. Cust. Appls., 19.

In a decision by the court and invoked by the importer, the merchandise was described as a pigment containing ultramarine blue of a pale blue tint, but not possessing the strength of commercial ultramarine blue. This was held not to be the ultramarine blue of commerce, but dutiable as a pigment under the act of 1897.—G. A. 6636 (T. D. 28294).

Ultramarine blue was declared to differ from a lake in that the blue was produced in the furnace and the lake by saturation.—G. A. 3437 (T. D. 17056). This was under the act of 1894.

[1] Miscellaneous Series No. 82.

Bleachers' blue containing ferrocyanide of iron, used exclusively for bleaching purposes was held dutiable as an unenumerated manufactured article and not as a color under the act of 1897.—De Ronde *v.* United States, 1 Ct. Cust. Appls., 104, Abstract 26014, T. D. 31744.

The blues referred to in paragraph 45 of the act of 1897 were declared to be blues in paints and colors.

BLACK PIGMENTS.

[Par. 53, act of 1913, 15 per cent ad valorem.]

SUMMARY.

Paragraph 53 of the tariff act of 1913 reads as follows:

Black pigments, made from bone, ivory, or vegetable substance, by whatever name known; gas black and lampblack, dry or ground in or mixed with oil or water, 15 per centum ad valorem.

This provision includes a wide variety of black materials, which when finely ground and mixed with the proper vehicle—e. g., linseed oil—will form paint. Carbon is the base for nearly all black pigments.

Black pigments may be divided into five groups: (1) Soot blacks, which include lampblack, carbon black, gas black, acetylene black, benzol black, and other black pigments obtained by the incomplete combustion of many substances, such as natural gas, crude petroleum oil, dead oil (obtained from coal tar by distillation and from resinous woods, tar, and pitch). Carbon black, one of the most important of the class, is generally made by burning natural gas so that the flame impinges on a metal surface, where the carbon is deposited and later removed by scraping. It is largely used as a filler in rubber, in the manufacture of printing ink, in stove polishes, and in paints. (2) The animal blacks, which form the second group, are principally obtained by calcining bones. Certain high grades are made from ivory chips or from carefully selected bones. These are known as ivory black and drop black to distinguish them from the other forms of bone black. (3) The charcoal blacks are obtained by charring willow, maple, bass, and similar soft woods. A special grade product, known as vine black, is obtained by charring grape vines. (4) The mineral blacks are powdered shale or slate and appear in commerce under the names of mineral black, slate black, black chalk, etc. Powdered coal, graphite, manganese ores, and asphaltum are occasionally used as black pigments. (5) The fifth class are the black lakes, which consist of coloring matter precipitated onto an inert base such as barytes and aluminum hydroxide. Logwood, nigrosine, and other coal-tar dyes are largely used.

The manufacture of black pigments is a comparatively large industry, representing in 1914 an invested capital of $5,000,000, employing 437 persons, and having a total output valued at but slightly less than $3,000,000. This included 44,500,000 pounds of bone black valued at $1,532,000, 22,900,000 pounds of carbon black worth $918,000, and 11,200,000 pounds of lampblack with a reported value of $503,856. The output of carbon black in 1918 is estimated to have been practically double the 1914 production.

The United States has a considerable export trade in black pigments, especially in lampblack and carbon black. The value of the exports in 1914 amounted to about one-eighth of the total production.

Since that time there has been a large increase, due perhaps to the increased prices. In 1919 the exports reached a maximum of $1,573,740, which was practically double the highest figure reported before the war. England and other European countries have been our largest customers, though in recent years large quantities have been shipped to the Latin-American countries and to the Far East.

Imports, on the other hand, have been very small and of little significance. The average value for the five years prior to the war (1910–1914) was $26,132. Since 1915, imports have been small and sporadic.

Black pigments were dutiable at 25 per cent ad valorem under the acts of 1883 and 1890. In 1894 the rate was reduced to 20 per cent, but in 1897 was returned to 25 per cent, which rate remained unchanged until reduced by the act of 1913 to 15 per cent.

The tariff classification of the two varieties of bone black have in the past occasioned considerable litigation. "Bone char not suitable for use as a pigment" which enters free of duty under paragraph 477. differs from pigment bone black only in that the latter is more finely ground.

Black pigments—Summary table.

Fiscal Year.	Domestic production.[1] [2]	Imports for consumption.[2]	Domestic exports.[2]	Ratio to production (per cent).	
				Imports.	Exports.
1910	.....	$23,394	$629,939	.....	.....
1911	.....	26,064	813,984	.....	.....
1912	.....	22,544	658,849	.....	.....
1913	.....	31,056	470,439	.....	.....
1914	$2,971,633	27,604	389,081	0.93	13.1
1915	.....	24,459	392,997	.....	.....
1916	.....	2,396	784,332	.....	.....
1917	.....	6,388	1,149,069	.....	.....
1918	.....	279	783,408	.....	.....
1919	.....	5,118	1,573,740	.....	.....

Year.	Value (imports for consumption).	Amount of duty.	Value per unit.	Equivalent ad valorem rate.
				Per cent.
1910	[3] $23,394	$5,848.50		25.00
1911	26,064	6,516.00	.....	25.00
1912	22,544	5,636.00	.....	25.00
1913	31,056	7,764.00	.....	25.00
1914	27,604	5,234.90	.....	25.00–15.00
1915	24,459	3,668.85	.....	15.00
1916	2,396	359.40	.....	15.00
1917	6,388	956.52	.....	[4] 15.00–12.00
1918	279	41.85	.....	15.00
1919	5,118	768.00	.....	15.00

[1] Includes animal charcoal and blacks used in fertilizers, sugar refining, etc., in addition to that used as pigment.
[2] Fiscal years.
[3] Calendar years.
[4] Imports valued at $56 from Cuba (under reciprocity agreement).

General Information.

Tariff act of 1913.—Par. 53: "Black pigments, made from bone, ivory, or vegetable substance, by whatever name known; gas black and lampblack, dry or ground in or mixed with oil or water, 15 per centum ad valorem."

DESCRIPTION.

Black pigments almost invariably contain carbon as a base. There is a wide variety of these pigments and they are made from many different kinds of material and are known by many different names. But they can all be grouped under five groups, viz: (1) Soot black; (2) animal blacks; (3) charcoal blacks; (4) mineral blacks, and (5) black lakes.

(1) *Soot blacks.*—Soot blacks are all obtained by the incomplete combustion of mineral oils, greases and fat-oils, resins, tarry matters, or natural gas. *Acetylene black*, which is obtained by the explosion of acetylene gas in a cylinder with a limited supply of air, may also fall in this group, as do lampblack, carbon black, gas black, smoke black, vegetable black, candle black, flame black, etc. The most important of these are described below.

Lampblack is the condensed smoke or soot produced by the partial combustion of organic substances. It is generally made from "dead oils" separated from coal tar or from the residues of petroleum refining. But where these products are not available, it may be made from resinous woods, tar, pitch, etc.

As now manufactured, lampblack is exceptionally pure, containing 99.5 per cent or more of carbon. Occasionally, however, samples are encountered that contain some unburned oil. According to Toch, this oil had to be removed by a naphtha treatment, but this is no longer necessary.[1] The presence of oil prevents the drying of the paint within a reasonable length of time, as lampblack at best is a very slow drying paint material. It is one of the bulkiest of pigments. One pound of it, without undue pressure, will occupy over 200 cubic inches, often as much as 230 cubic inches (1 gallon). The color is distinctly gray as compared with the animal blacks or with carbon black. When tinted out with white, it has a bluish tinge, whereas bone blacks show brownish.

Carbon black [2] is similar to lampblack except that it has an intensely black color. While it has high tinctorial power, its use has been somewhat restricted in mixed paints because it produces a streaky color and separates out from the rest of the mixture.[3] It is much used in printing ink, rubber compounding, for coloring cement mortar, etc. The product is free from oily matter and mixes well with water, but with difficulty with oil.

Carbon black is made by burning gas (especially natural gas) so that the flame impinges on a horizontal, rotating iron plate (frequently water-cooled). The sudden lowering of the temperature of the flame causes a deposit of carbon, which is removed from the plate by a scraper.

Benzol black is a carbon black made from benzol instead of gas.[4]

(2) *Animal blacks.*—There are a great many animal blacks, varying from ivory black, which is obtained by the calcination of ivory chips, to sugar-house black, a by-product of the sugar mills. The composition of all these blacks is similar in that they all contain carbon and calcium phosphate. The carbon content varies from 10 to

[1] Chemistry and Technology of Paints. Von Nostrand, 1916.
[2] "Gas carbon" is the cake that gathers in the pipes and flues of by-product coke ovens, gas plants, and similar establishments. It is not a pigment, but is used principally for making artificial graphite.
[3] Toch: Loc. cit.
[4] Benzol is a product obtained in the distillation of coal tar.

20 per cent, the rest being phosphate of lime and moisture. A little carbonate of lime is sometimes present.

Some of the best blacks are made from the shin bone and skull of sheep, and these blacks have the most intense black color. The highest-priced blacks are those having the most intense black color and which will not settle out in varnish or oil. Such blacks are made by digesting carefully selected burnt bones or ivory chips in hydrochloric acid, which removes the lime salts and leaves the carbon in the form of a flocculent residue. This carbon is frequently sold under the name "black toner," because it is used to "tone up" other blacks.[1]

Bone black.—Ordinary bone black is made from bones charred in a retort. Coarsely pulverized, it is used for decolorizing sirups and oils. Large quantities are used in the refining of sugar, for which purpose it is more often known as bone char.[2] Paragraph 447 of the tariff act of 1913 contains a provision for the free entry of bone black "not suitable for use as a pigment." The principal difference in the two forms of bone black is in the fineness of grinding, and the phrase "not suitable for use as a pigment" is not an accurate description of the article and has occasioned considerable litigation. (Reference should be made to the Tariff Information Survey on Bone Char and Blood Char, par. 447.) The bone black used as a pigment should be sufficiently fine that all of it will pass through a 250-mesh sieve. Some paint grinders require that over 99 per cent shall pass through a 350-mesh sieve. Sugar refiners, on the other hand, prefer bone black running from 16 to 30 mesh.

Drop black.—So-called drop black is a bone black that is sold at a higher price because of the intensity of its color. The name comes from the former practice of grinding calcined sheep bones in water to an impalpable paste, which was then formed into cone-shaped drops. Drop black therefore became a synonym of a good black, and the name still clings to the finely powdered black now on the market. The composition is largely calcium phosphate, with only from 10 to 20 per cent of carbon.

(3) *Charcoal blacks.*—Charcoal from willow, maple, and bass trees is largely used as pigment in black paints. Many of these paints consist of charcoal, lampblack, litharge, and linseed oil. Such paints tend to solidify in the package (because of the litharge), but they are excellent preservatives for structural steel. Some charcoal is produced at paper mills, but the product contains up to 2 per cent of carbonate of potash, which unfits it for use in oil paints. Such material, however, is much used in the manufacture of oilcloth and coated leather.

Vine black.—This pigment is in reality charcoal black that is made by charring grapevine. The grain is finer than ordinary charcoal and is denser. It is likely, however, to be too alkaline for general use with linseed oil.

(4) *Mineral blacks.*—Heavy black slate or shale is used to some extent in paint for buildings, but is used chiefly as black filler for ironwork. It is often toned with other blacks (carbon or lampblack) that are not so heavy, but the consumption is small because of its destructive action on paint mills and because its tinctorial

[1] Black toner best serves its purpose in what is known as Black Color in varnish. Black paint composed of black toner ground in linseed and reduced with very high-grade coach varnish is worth (according to Toch) from $4 to $6 per gallon.

[2] Blood char is also used for this purpose. These blacks, when imported, are free of duty and come under par. 447, act of 1913. (See p. 46.)

power is not high. Quite as satisfactory results are obtained by the use of fine silica tinted with lampblack, and at less cost. These blacks (mineral black, slate black, oil black, black chalk, etc.) are perhaps more important abroad than in this country and are found in abundance in Bavaria, Spain, Italy, and elsewhere.

Coal.—Powdered coal of various kinds is likewise used in some paints. It generally contains sulphur compounds, which are exceedingly harmful to metal and which prevent its being mixed with lead pigments. The use is not increasing.

Manganese ores.—Pyrolusite and hausmannite (natural oxides of manganese) are sometimes powdered for use as pigments, but their most important application in the paint trade is as driers in the preparation of boiled linseed oil.

Graphite, or crystalline carbon, both natural and artificial, is a very important paint pigment. Its extreme lightness requires that it be diluted with a heavier base to give it "tooth" and prevent it from being spread too thin. If used alone, 1 gallon of graphite paint will cover from 1,000 to 1,600 square feet of surface, or two or three times as much as most other pigments. Few graphite paints contain as much as 60 per cent graphite, since, in addition to its spreading too thin, it is also a slow drier.[1]

Asphaltum.—Asphalts and bitumens are frequently used in the paint trade, although they are not strictly pigments. Natural asphalt may be considered as a mineral black, but there is no question of its being classified under pigments, as it is specifically provided for under paragraph 534 of the act of 1913.

(5) *Black lakes.*—Lakes of various kinds have been employed as black pigments. They are, however, of minor importance. Various coloring agents are used, including logwood decoction and potassium dichromate with copper sulphate, tannate of iron, and coal-tar colors. They are rapidly being displaced by black toners made from carbon blacks. These, however, are sometimes toned up by precipitating nigrosine (an aniline dye) on them. A high-grade black pigment is made by precipitating red, yellow, and blue aniline dyes upon the extract of ivory black, and this pigment is unusually flocculent and remains in suspension for a long time.

DOMESTIC PRODUCTION.

The total production of bone, carbon, and lampblack as reported by the census of 1914 was valued at $2,953,947. Approximately, one-half of this represents the value of bone black,[2] one-third of it was carbon black, and one-sixth was lampblack. This figure does not include black pigments made and consumed by paint manufacturers and others, and marketed in the form of paint or other finished product, and which were not reported. It does include, however, the output of firms engaged primarily in the manufacture of fertilizers, paints, or varnishes. Such firms produced a total amount exceeding the output of all the establishments engaged primarily in the manufacture of blacks.

The Bureau of Mines[3] states that during 1918 the estimated production of carbon black was 43,500,000 pounds, of which 30,000,000

[1] For further information in regard to graphite (plumbago), see separate unit of the Tariff Information Survey.

[2] The Fuel Administration claimed that many of the West Virginia plants were extremely wasteful of gas, and several plants were closed as a war measure in 1917–18.

[3] "Carbon Black Industry Surveyed," by Roy O. Neal, chemical engineer, Bureau of Mines, The Chemical Engineer, April, 1920, pp. 121–3.

pounds was manufactured in West Virginia and 1,500,000 in Oklahoma. The estimated distribution of this quantity was as follows:

	Pounds.
Rubber industry	20,000,000
Printers' ink	10,000,000
Exported	8,000,000
Stove polish	4,000,000
Phonograph records	500,000
Other uses (paint, carbon paper, etc.)	1,000,000

Process of manufacture.—There are three principal methods of manufacture of blacks, each process yielding a characteristic product. Some of these processes have been briefly mentioned above. The following are the only important processes in the United States:

(1) Deposition of carbon black by the imperfect combustion of natural gas, the flame impinging upon an iron plate which receives the deposit of soot. The modification most used is the so-called channel process, in which the black is deposited on the undersurfaces of steel channels by lava tip burners set at a distance of 3 to 4 inches.

(2) Deposition of lampblack by the incomplete combustion of coal tar, wood tar, petroleum, rosin, etc., the dense smoke being deposited as soot in chambers.

(3) Carbonization of bones in retorts for the making of bone black.

Persons engaged in the industry.[1]—The total number of persons, engaged in the industry in 1914 was 437, of whom 339, or 77.6 per cent, were wage earners; 74, or 16.9 per cent, were proprietors or officials; and 24, or 5.5 per cent, were clerks (including other subordinate salaried employees). Five of the wage earners and nine of the clerks were women.

The largest number of wage earners employed was 390 for October; the smallest number was 300 for March. Data from previous censuses indicate that the last quarter of the year is the period of maximum employment, whereas the minimum number is reported for the first quarter. The minimum number of wage earners, however, has generally been in excess of 80 per cent of the maximum for the same year; and in 1914, the year which shows the greatest variation (due probably to unusual expansion of the industry), the minimum employment is 88.5 per cent of the average for the year.

Of the total of 27 establishments in 1914, 18 were under corporate ownership and these plants produced 73.5 per cent of the total output. The tendency of the industry to concentrate in large establishments is well illustrated by the statistics on page 41. Six establishments, each producing more than $100,000 worth of product yearly, reported 62.5 per cent of the 1914 total output. The average output per establishment in 1914 was $54,206, as compared with only $25,909 in 1904. In the earlier year no establishment reported an output valued at as much as $100,000.

Capital.—The total capital invested in the industry in 1914 was $4,995,400.

Localities of production.—Two-thirds of the establishments that reported production in 1914 were located in West Virginia and the production, consisting almost wholly of carbon black and some lampblack made from natural gas, amounted to 58.2 per cent of the total for the United States. Other producing States, with the number of establishments in each, were: Massachusetts, 2; New Jersey, 1; New

[1] Data from Federal Census.

York, 1; Ohio, 1; Oklahoma, 1; and Pennsylvania, 3. The capital invested in West Virginia plants was 82.5 per cent of the total.

Domestic production and consumption.—The United States is practically self-supporting as regards its supply of blacks. As in the case of most pigments, however, there are consistent importations of special qualities.

Digest of census statistics for the industry.

Year.	Number of establishments.	Wage earners (average number).	Wages.	Cost of materials.	Value of products.	Value added by manufacture.	Capital invested.
1914	27	339	$336,001	$686,240	$1,463,569	$777,329	$4,995,400
1909	27	228	149,327	444,608	1,093,494	648,886	1,841,966
1904	25	200	105,159	203,396	647,717	444,321	1,663,143
1899	15	85	46,107	105,712	359,787	254,075	782,247
1889	24	323	216,288	485,867	1,031,030	545,163	1,627,651
1879	18	224	80,249	440,068	661,376	221,308	627,350
1869	9	56	20,734	107,565	193,800	86,235	(?)
1859	24	168	52,176	179,288	376,710	197,422	.....
1849	5	24	7,056	20,925	42,250	21,325	.....

It is probable that the decreases shown for 1899 as compared with 1889 are due to differing classifications of establishments reporting. The same reason may be assigned for variations shown in the statistics of other censuses.

In addition to the productions recorded in the above table, bone black to the value of $961,995 was made in 1909 by establishments engaged primarily in the manufacture of fertilizers and glue; and manufacturers of paint and varnish reported lampblack and other blacks made for sale as pigments, to the value of $105,063. These figures bring the value of the total output for 1909 up to $2,160,552.

In 1914 the output of establishments in the paint industry and in the fertilizer industry was an even greater factor, and together furnished very nearly as large an amount as was reported by the establishments engaged primarily in the manufacture of these blacks. The total production for 1914 was $2,953,947, but this does not include black pigments made and consumed by paint or other manufacturers, and marketed in paint or other form. The production of such intermediates was not reported.

The following data, showing the statistics in greater detail, are available only for 1909 and 1914:

	1914	1909
Number of establishments	39	57
Bone, carbon, and lampblack industry	27	27
Paint and varnish industry	7	30
Fertilizer industry	5	
Bone, carbon, and lampblack industry	$1,463,569	$1,093,494
Paint and varnish industry	94,898	105,063
Fertilizer industry	1,413,166	961,995
Bone black (animal charcoal):		
Number of establishments	7	7
Pounds	44,509,000	(1)
Value	$1,532,000	$1,070,333
Carbon black:		
Number of establishments	20	18
Pounds	22,869,000	(1)
Value	$918,091	625,514
Lampblack:		
Number of establishments	12	32
Pounds	[2] 11,200,000	(1)
Value	$503,856	$439,707
All other products	$17,686	$24 998

[1] Figures not available.

[2] Includes $215,212, the value of 4,786,394 pounds; and $288,644, for which no quantity was reported. Total quantity estimated at 11,200,000 pounds.

Domestic exports.[1]—The United States has been a rather large exporter of black pigments, chiefly lampblack and carbon black. The exports in 1905 were in excess of $500,000 in value. There was considerable variation from year to year. The maximum exports before the war were in 1912 when they were valued at $907,623. This was followed by a marked falling off in 1913 and it was not until 1917 that the exports exceeded or again approached the record of 1912. But in 1919, due in large measure to greatly enhanced prices, the exports established a new maximum value of $1,573,740.

Before the war, the exports of black pigments were chiefly to Europe, especially to Great Britain, although Germany and France also absorbed large quantities. The exports to Germany showed some decline in 1914 and ceased abruptly soon after the outbreak of the war. Larger quantities were then exported to England and other European countries; and since 1917 greatly increased amounts have been exported to Latin-American countries, which had hitherto been comparatively unimportant consumers of American blacks. Larger quantities were also shipped to the Far East.

FOREIGN PRODUCTION.

Germany was doubtless the largest foreign producer of black pigments; but Great Britain, France, Netherlands, Austria, and many other countries produce large amounts, chiefly for home consumption. The raw materials vary somewhat in the different countries. For instance, lampblack and carbon blacks are made in Germany from lignite and coal-tar residues, and the best drop black, and other charcoal blacks (Frankfort black, etc.) are made from spent wine yeast as well as grape skins and twigs of grapevine.

IMPORTS.

Imports of black pigments have been very small as compared with the domestic production. Many varieties, however, have been imported. In 1914, 27 different varieties of black pigments are recorded among the imports, coming chiefly from Germany and England with smaller amounts from France, Netherlands, and Austria. The one importation of animal carbon came from Canada. There was also a little black paint imported in that year, mostly from Great Britain, and only small amounts from Germany, and a trifle from France.[2] The average value of the imports for the five years before the war (1910–1914, inclusive) was $26,132 annually. Even under the 25 per cent duty existing at that time, the revenue was far from large. Since 1915, the imports of black pigments have been absolutely negligible; the total value in 1918 amounted to only $279.

PRICES.

New York quotations for several of the standard grades of black pigments will be found on page 44. At the outbreak of the war, the quotations ranged from 2½ and 5 cents per pound for ordinary powdered bone black to 8 and 12 cents per pound for ivory black. After

[1] The references under this topic are to fiscal years.
[2] These statements are based on the survey of the imports of chemical and allied products, by Dr. E. R. Pickrell, Department of Commerce, Miscellaneous Series No. 82.

the outbreak of the war, prices did not advance materially until 1916. A general advance began in that year with the result that in 1918 black pigments had, almost without exception, at least doubled in value. The most marked increases were registered in lampblack and carbon gas black, which were selling in 1918 at five times the prices that prevailed in August, 1914. Prices of lampblack and carbon black fell off somewhat during 1919, but prices for the other pigments continued at the same high level during 1919 and 1920.

TARIFF HISTORY.

Black pigments were dutiable at 25 per cent ad valorem under the act of 1883 [1] and this rate was continued in all the subsequent acts until 1913, except for the three years under the act of 1894, when the rate was 20 per cent. The act of 1913 reduced the duty to 15 per cent, but without any apparent effect upon the volume of imports. In fact, the imports during the first quarter of the fiscal year 1914 (under the 25 per cent rate) were practically two-thirds as much as came in during the remaining three quarters (under the 15 per cent rate).

TARIFF CONSIDERATIONS.

The black pigments present no problems in tariff classification, except in the case of bone black. A grade of this material "not suitable for use as a pigment" enters free of duty under paragraph 477, while similar material differing only in the fineness of grinding is dutiable at 15 per cent as a black pigment made from bone (paragraph 53). (See discussion of Tariff Considerations in Survey on Bone Char and Blood Char, par. 477.)

Black, made from bone, ivory, or vegetable substances, including gas black and lampblack, dry or ground in or mixed with oil or water—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	25 per cent	570,950	$22,430	$5,607	$0.039	25
1910	do	1,295,258	23,394	5,848	.018	25
1911	do		26,064	6,516		25
1912	do		22,544	5,636		25
1913	do		31,056	7,764		25
1914 [2]	do		10,943	2,735		25
1914 [3]	15 per cent		16,661	2,499		15
1915	do		24,459	3,668		15
1916	do		2,396	359		15
1917	do		6,332	949		15
1918	do		279	41		15
1919	do	69,977	65,118	768		15
1917	15 per cent less 20 per cent. [4]		56	6		12

[1] "Bone-char" was mentioned in the act of 1883 in this same paragraph. In subsequent acts it was listed in separate paragraphs, finally being placed upon the free list in the act of 1913.
[2] Act of 1909—July 1 to Oct. 3, 1913.
[3] Act of 1913—Oct. 4, 1913, to June 30, 1914.
[4] From Cuba (reciprocity treaty, Dec. 27, 1903).

Lampblack—Domestic exports (fiscal years).

Exported to—	1910	1911	1912	1913	1914	1915
Austria-Hungary	$1,920	$1,200	$7,320	$240	$4,629	.....
Belgium	10,453	9,937	9,720	7,140	7,604	.....
Denmark	4,580	1,200	2,550	2,250	2,675	$68,338
France	77,509	108,508	96,405	111,696	87,874	29,629
Germany	148,648	159,668	195,240	194,289	138,465	23,422
Italy	4,490	5,505	7,675	9,347	8,713	13,736
Netherlands	26,896	36,711	43,146	19,431	16,087	1,901
United Kingdom	333,706	228,133	444,884	86,965	90,007	129,805
Central America	1,249	968	443	377	1,157	717
Mexico	12,407	813	1,803	712	846	1,795
Cuba	2,030	3,560	4,514	1,388	2,342	5,350
South America	2,024	655	703	1,628	4,630	6,401
China	3,216	5,615	6,654	4,098	2,971	1,198
Japan	14,801	20,406	30,565	3,791	8,596	9,733
Australia	1,586	2,909	3,194	2,691	5,509	6,644
Philippine Islands	916	476	1,256	299	699	163
Canada	30,255	42,909	49,311	52,333	34,620	32,999
All other	2,921	1,738	2,240	7,070	4,124	[1] 36,994
Total	679,607	640,911	907,623	505,748	421,548	368,825

[1] $30,289 to Russia in Europe.

Carbon, bone, and lampblack, domestic exports.

Exported to—	Fiscal years.			Calendar years.	
	1916	1917	1918	1918	1919
Denmark	$48,054	$3,410	.....	$12,555	$69,990
France	55,534	142,689	$116,921	69,895	214,160
Italy	7,671	9,849	10,513	12,000	18,244
Netherlands	3,774	3,708	.....	.....	21,116
Norway	7,889	.....	2,813	5,568	2,451
Spain	4,923	2,521	10,535	9,673	4,980
United Kingdom	259,093	604,353	463,935	142,287	589,888
Canada	46,174	73,101	172,456	211,771	271,686
Central America	1,579	3,900	1,279	1,687	3,581
Mexico	2,923	1,873	3,638	3,945	3,484
Cuba	1,504	3,900	23,751	30,740	65,624
Argentina	14,444	12,371	30,749	9,964	7,694
Brazil	2,632	3,110	8,237	3,910	3,794
Chile	384	1,230	1,223	1,191	1,080
Colombia	425	1,441	449	335	1,252
Venezuela	690	1,269	608	544	1,674
China	7,725	6,530	76,677	68,431	113,118
Japan	21,379	3,843	136,686	162,701	109,868
All other	34,666	38,530	50,795	35,220	70,056
Total	521,463	917,303	1,111,265	783,408	1,573,740

Blacks—Dry, prices, in cents, per pound.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919	1920
Bone, powdered:									
January [1]	3–5	2½–5	2½–5	2½–5	2½–5	4–8	4–12	5½–12	5½–12
April [1]	3–5	2½–5	2½–5	2½–5	3½–7	4–8	4–12	5½–12	5½–12
July [1]	3–5	2½–5	2½–5	2½–5	4–8	4–8	5½–12	5½–12	5½–12
October [1]	3–5	2½–5	2½–5	2½–5	4–8	4–8	5½–12	5½–12	5½–12
Carbon gas:									
January	6⅜–8	5–8	3⅜–8	4–6	5½–6½	14–20	20–30	16–25	12–25
April	6⅜–8	5–8	3⅜–6	4–6	10–12	22–32	23½–40	14–25	12–25
July	6⅜–8	4–8	3⅜–6	5½–6½	14–20	25–35	16–25	12–25	15–30
October	5–8	4–8	4–6	5½–6½	14–20	25–35	16–25	12–25	12–30
Drop:									
January	([2])	5–8	5–8	5–8	5–8	7–12	8½–15	5½–15	5½–15
April	([2])	5–8	5–8	5–8	6–12	7–12	5½–15	5½–15	5½–15
July	([2])	5–8	5–8	5–8	7–12	7–12	5½–15	5½–15	5½–15
October	([2])	5–8	5–8	5–8	7–12	8½–12	5½–15	5½–15	5½–15
Ivory:									
January	5–8	8–12	8–12	8–12	8–12	16–30	16–30	16–30	16–30
April	5–8	8–12	8–12	8–12	10–24	16–30	16–30	16–30	16–30
July	5–8	8–12	8–12	8–12	16–30	16–30	16–30	16–30	16–30
October	5–8	8–12	8–12	8–12	16–30	16–30	16–30	16–30	16–30

[1] Includes drop bone for 1912.

[2] See powdered bone.

Blacks—Dry—Prices.

[From Oil, Paint, and Drug Reporter.]

PER POUND WHOLESALE.

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919	1920
Lampblack:	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	4–10	6–7	3–7	3–7	5½–15	12–18	12–25	15–45	15–45
April	4–10	6–7	3–7	3–7	14 –18	14–20	12–25	15–45	15–45
July	4–10	3–7	3–7	4–8	12 –18	14–20	15–45	15–45	15–45
October	3–7	3–7	3–7	4–8	12 –18	14–20	15–45	15–45	12–40
Charcoal, willow, powdered:[1]									
January							4	6	6–7
April							4	6	6–7
July							4	6	6–7
October							4	6–7	6–7
Vine:									
January							4	4	4–5
April							4	4	4–5
July							4	4	4–5
October							4	4–5	4–5

PER TON IN CAR LOTS.

Mineral blacks:									
January	$20–$25	$18–$25	$18–$25	$18–$25	$18–$25	$20–$30	$25–$30	$35–$45	$35–$45
April	21– 25	18– 25	18– 25	18– 25	18– 25	20– 30	25– 30	35– 45	35– 45
July	21– 25	18– 25	18– 25	18– 25	20– 30	24– 30	35– 45	35– 45	35– 45
October	21– 25	18– 25	18– 25	18– 25	20– 30	24– 30	35– 45	35– 45	35– 45

[1] Not quoted prior to 1918.

Blacks—In oil—Prices, in cents per pound, in 1-pound and 5-pound cans.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919	1920
Coach black in japan:									
January	20–30	20–30	20–30	20–30	20–30	24–32	28–35	28–40	28–40
April	20–30	20–30	20–30	20–30	24–32	24–32	28–35	28–40	28–40
July	20–30	20–30	20–30	20–30	24–32	24–32	28–40	28–40	28–40
October	20–30	20–30	20–30	20–30	24–32	24–32	28–40	28–40	28–40
Coach black in oil:									
January	14–18	14–18	14–18	14–18	14–18	16–22	20–25	26–32	32–36
April	14–18	14–18	14–18	14–18	16–22	16–22	20–25	26–32	32–36
July	14–18	14–18	14–18	14–18	16–22	16–22	26–32	32–36	32–36
October	14–18	14–18	14–18	14–18	16–22	16–22	26–32	32–36	32–36
Drop black in oil:									
January	14–18	14–18	14–18	14–16	14–16	16–22	20–25	26–32	32–36
April	14–18	14–18	14–16	14–16	16–22	16–22	20–25	26–32	32–36
July	14–18	14–16	14–16	14–16	16–22	16–22	26–32	32–36	32–36
October	14–18	14–16	14–16	14–16	16–22	16–22	26–32	32–36	32–36
Lampblack in oil:									
January	12–14	12–14	12–14	12–14	12–14	24–30	28–35	30–40	40–45
April	12–14	12–14	12–14	12–14	24–30	24–30	28–35	30–40	40–45
July	12–14	12–14	12–14	12–14	24–30	24–30	30–40	40–45	40–45
October	12–14	12–14	12–14	12–14	24–30	24–30	30–40	40–45	40–4.

Black pigments—rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	88	The pigment known as bone black, and ivory-drop black, and bone char.	25 per cent ad valorem.
1890	52	Black, made from bone, ivory, or vegetable, under whatever name known, including bone black and lampblack, dry or ground in oil or water.	Do.
1894	40	Black, made from bone, ivory, or vegetable, under whatever name known, including bone black and lampblack, dry or ground in oil or water.	20 per cent ad valorem.
1897	47	Black, made from bone, ivory, or vegetable substance, by whatever name known, including bone black and lampblack, dry or ground in oil or water.	25 per cent ad valorem.
1909	45	.....do.....	Do.
1913	53	Black pigments, made from bone, ivory, or vegetable substance, by whatever name known; gas black and lampblack, dry or ground in or mixed with oil or water.	15 per cent ad valorem.

Court and Treasury Decisions.

Merchandise described as "vegetable black made from bone" and used principally for clarifying or purifying chemicals was classified under paragraph 45 of the act of 1909 (Abstract 37721, of 1915); but black made from bone, ivory, or vegetable substances, used for decolorizing purposes and classified as a pigment under the corresponding paragraph (53) of the act of 1913, was held exempt from duty as "bone black, not suitable for use as a pigment," under paragraph 447. (Abstract 37347, of 1915.)

See also Tariff Information Surveys on Bone Char and Blood Char (par. 477, act of 1913), and Paints and Pigments (par. 63, act of 1913).

BLOOD CHAR AND BONE CHAR NOT SUITABLE FOR USE AS A PIGMENT.

Summary.

Par. 447 (free list).—"* * * blood char, bone char, * * * not suitable for use as a pigment."

Blood char and bone char, known generally as "animal charcoal," are porous forms of carbon obtained by charring dried blood and bones. The variety not suitable for use as a pigment is used chiefly for decolorizing sugar, glucose, and other organic solutions. To be used as a pigment, bone char must be finely ground, and therefore only the granular and unground varieties are included under this provision.

Production of animal charcoal was reported by seven establishments in 1914, who had an output of 44,509,000 pounds, valued at $1,532,000. This was an increase of 43.3 per cent over the value reported during 1909.

Imports of blood char and bone char in 1914 were valued at $79,506, or approximately 5.2 per cent of the domestic production. Prewar imports of bone char averaged about $20,000 in value, but a considerable increase in imports occurred when this article was placed on the free list by the act of 1913. The average annual value of the imports for 1915–1919 was $62,141. Blood char is imported in much smaller quantities. The maximum (in 1914) amounted to 26,674 pounds, valued at $1,789. During 1916, 1917, and 1918 practically no imports were made.

Bone char was dutiable at 25 per cent ad valorem under the acts of 1883 and 1890 and at 20 per cent under the acts of 1894, 1897, and 1909. The limitation "suitable for use in decolorizing sugars" appeared in the acts of 1894, 1897, and 1909. Blood char was included in the provision in 1909 and given the same rate of duty as bone char. In the act of 1913 both blood char and bone char not suitable for use as a pigment were placed on the free list.

General Information.

DESCRIPTION.

Blood char and bone char are porous forms of carbon, which are sometimes known by the general name of "animal charcoal." These products are obtained by heating dried blood and bones in a closed retort until all of the volatile matter is driven off. The following

chemical analyses of different samples of bone char show the average chemical composition of this material.

	Sample No. 1.	Sample No. 2.	Sample No. 3.	Sample No. 4.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Phosphate of lime	75.12	75.04	70.0	76.95
Carbon	10.80	12.00	12.0	9.80
Carbonate of lime	6.25	.....	15.0	7.50
Iron	.15	.....	.....	.10
Alumina and silica	.87	.10	.....	.50
Sulphate of lime	.35	.....	.....	.35
Water	6.46	6.04	3.0	5.00

The principal difference between bone char used for decolorizing purposes and that used as a pigment in paint manufacture consists in the grinding. Bone char for the former use is in a granular form, the grains varying from the size of a pea to the size of a pinhead. Bone char pigment is very finely ground and is known to the paint trade as "powdered bone black."[1] Material which must be subjected to processes of grinding and cleaning to become pigments has been held to come within this provision, since in the condition as imported it is "not suitable for use as a pigment." (T. D. 34344.)

Sugar refiners prefer bone black running from 16 to 30[2] mesh, and their contracts commonly provide that there shall not be more than 5 per cent finer than 30 mesh. Paint grinders, on the other hand, usually require that bone black to be used as a pigment shall be sufficiently fine that all of it will pass through a 200-mesh sieve. Many of their specifications insist that at least 99 per cent shall pass through a 350-mesh screen. A typical screen analysis of bone black to be used in sugar refining is as follows:

	Per cent.
Oversize	6.7
8–10 standard mesh	48.4
10–14 standard mesh	37.8
14–20 standard mesh	4.6
20–28 standard mesh	1.0
28–35 standard mesh	.6
Fines standard mesh	.5

USES.

Animal charcoal has the power of absorbing many substances, such as organic coloring matters and gases, and it therefore is largely used as a decolorizer in refining sugar, glucose, and other organic solutions. In the purification of certain vegetable oils and paraffin, bone char or blood char is used in the filter medium. Other uses are in small filters for drinking water, in the manufacture of some blackings, in casehardening of iron, and occasionally as a means of absorbing odors in apartment houses and other buildings. Animal charcoal used for clarifying purposes is usually revivified and reused. The process of revivification consists in reheating the charcoal in a closed retort until all of the absorbed material is charred. After

[1] Bone black pigments are discussed in a separate Tariff Information Survey for "Black Pigments." (Par. 53, act of 1913.)

[2] Also known as No. 16 and No. 30 sieves.

several reburnings the absorptive quality is greatly diminished, and finally the material—known as "spent bone black"—is sold for fertilizer purposes.

MANUFACTURE.

Blood char is made by heating dried blood in a closed retort until all volatile matter has been driven off.

In the manufacture of bone char the bones must first be treated to remove fat. The fat is sometimes removed by boiling with water or heating with steam, or it may be removed by treatment with a solvent, such as benzine or carbon disulphide. After the removal of the fat the bones are put into an air-tight retort and heated until the volatile matter is driven off. This operation usually lasts from 6 to 10 hours. The volatile matter consists of bone oil, ammonia, and other gases. The bone oil and ammonia are collected and utilized as by-products. After the heating the charcoal must be cooled in air-tight vessels.

DOMESTIC PRODUCTION.

In 1909 there were seven establishments reported to be manufacturing animal charcoal, with an output valued at $1,070,333. In 1914 the same number of establishments produced 44,509,000 pounds, valued at $1,532,000. Later figures for the production are not available, but three plants reported a total output of 8,942,000 lbs. in 1918. These figures include the production of animal charcoal for use as a pigment, but it is believed that most of the output was bone char for use in sugar refining and fertilizers.

IMPORTS.

The imports of bone char not suitable for use as a pigment have shown considerable variation since 1908. Before it was placed on the free list by the act of 1913, imports were in the neighborhood of $20,000. They increased from $12,484 in 1913 to $77,717 in 1914, and reached a maximum of $120,715 in 1915. For the period 1916–1919 the average annual value of the imports was $62,141. In 1914 the imports were received from the following sources: France, 41.1 per cent; England, 30.5 per cent; Germany, 19.3 per cent; Scotland, 8.9 per cent; and Netherlands, 0.2 per cent.

Blood char is imported in considerably smaller amounts. The maximum import in recent years occurred in 1914 and amounted to 26,674 pounds, valued at $1,789. All of the imports during 1914 came from Germany. In 1915, 14,167 pounds were received, but there were practically no imports during 1916, 1917, and 1918. During the fiscal year 1919, 10,732 pounds, valued at $441, were imported.

EXPORTS.

Since 1916 Commerce and Navigation has shown the annual exports of "Carbon, bone, and lampblack." These amounted to $521,463 in 1916, $917,303 in 1917, and $1,111,265 in 1918. The exports are believed to be almost entirely carbon and lampblack. A small quantity of bone black is no doubt exported, but probably not the variety used for decolorizing purposes.

PRICES.

Domestic prices for blood char are not quoted in most of the trade journals. The value per unit of quantity in the import tables has shown considerable variation, ranging from 4 cents per pound in 1919 to $1.06 per pound in 1916. The former figure is believed to more nearly approximate the average price of this article. The prewar price for blood char was in the neighborhood of 10 cents per pound.

Powdered bone char has varied in price from 2¼ and 5 cents per pound in 1914 to 5½ and 12 cents during 1919. Bone char for decolorizing purposes is not quoted, nor do the import tables list the value per unit of quantity. During 1918 the sugar refiners paid between 5½ and 7 cents per pound for their bone char.

TARIFF HISTORY.

Bone char was mentioned specifically in the act of 1883 and made dutiable at 25 per cent ad valorem. In the act of 1890, "bone char, suitable for use in decolorizing sugars," was dutiable at 25 per cent ad valorem. The rate was reduced to 20 per cent in the act of 1894, and continued in the acts of 1897 and 1909. Blood char was included in the provision in 1909 and given the same rate. In the act of 1913 the language was changed to read: "Charcoal, blood char, bone char, or bone black, not suitable for use as a pigment," and the provision was transferred to the free list.

TARIFF CONSIDERATIONS.

Relation to the cost of sugar refining.—The cost of bone char represents about 2 per cent of the total cost of refining sugar, according to the following table, which was prepared from data presented in the Tariff Commission's report on "Refined sugar: Costs, prices, and profits (1920)":

Comparison of the average cost of bone char per pound of refined sugar, with the total cost of refining.

[Figures taken from the books of a number of representative refineries.]

Year.	Cost of bone char.	Total refining cost.	Year.	Cost of bone char.	Total refining cost.
1914	$0.00010	$0.00420	1917	$0.00015	$0.00713
1915	.00010	.00424	1918	.00019	.00861
1916	.00009	.00452	1919 (6 months)	.00017	.00889

TARIFF CLASSIFICATION.

Paragraph 447 of the act of 1913 contains a provision for the free entry of bone char "not suitable for use as a pigment," while under the operation of paragraph 53 of the same act "black pigments, made from bone," are dutiable at 15 per cent ad valorem. These two varieties of bone black, as pointed out elsewhere in this survey, differ only in fineness of grinding. The limitation "not suitable for use as a

pigment" does not definitely identify a particular type of material, and it has therefore occasioned considerable litigation. The difficulty in classification might be avoided by including all varieties of bone black, irrespective of use, under one provision. If, however, it is desired to continue to differentiate between the different varieties of bone black, it is suggested that the distinction be made on the basis of fineness of grinding. Requirement that all of the material shall pass through a 100-mesh (No. 100) sieve would include all "black pigments made from bone" and would exclude the coarser bone char used for decolorizing sugar and other solutions.

Bone char or bone black, not suitable for use as a pigment—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1909	20 per cent		$5,481	$1,096		20
1910	do		18,232	3,646		20
1911	do		22,448	4,489		20
1912	do		20,414	4,082		20
1913	do		12,484	2,496		20
1914	do		97	19		20
1914 [1]	Free		77,620			
1915 [2]	do		120,715			
1916	do		86,724			
1917	do		80,163			
1918	do		11,865			
1919	do		69,813			

[1] Act of 1909—July 1, 1913, to Oct. 3, 1913, "Bone char, suitable for use in decolorizing sugars."
[2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Blood char—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	20 per cent		$347	$69		20
1911	do	661	347	69	$0.52	20
1913	do	2,954	333	66	.11	20
1914	Free	26,674	1,789		.06	
1915	do	14,167	1,196		.08	
1916	do	15	16		1.06	
1919	do	10,732	441		.040	

Powdered bone black—Prices, per pound, wholesale, New York.[1]

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
January, 1912[2]	3 - 5	July, 1916	4 - 8
April, 1912[2]	3 - 5	October, 1916	4 - 8
July, 1912[2]	3 - 5	January, 1917	4 - 8
October, 1912[2]	3 - 5	April, 1917	4 - 8
January, 1913	2½- 5	July, 1917	4 - 8
April, 1913	2½- 5	October, 1917	4 - 8
July, 1913	2½- 5	January, 1918	4 -12
October, 1913	2½- 5	April, 1918	4 -12
January, 1914	2½- 5	July, 1918	5½-12
April, 1914	2½- 5	October, 1918	5½-12
July, 1914	2½- 5	January, 1919	5½-12
October, 1914	2½- 5	April, 1919	5½-12
January, 1915	2½- 5	July, 1919	5½-12
April, 1915	2½- 5	October, 1919	5½-12
July, 1915	2½- 5	January, 1920	5½-12
October, 1915	2½- 5	April, 1920	5½-12
January, 1916	2½- 5	July, 1920	5½-12
April, 1916	3½- 7	October, 1920	5½-12

[1] These prices are for the powdered bone black, suitable for use as a pigment. Decolorizing bone black not quoted.
[2] Bone and drop.

Bones, soft, steamed, unground—Prices, per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$21.5-$22	January, 1918	$26
January, 1915	21.5- 22	April, 1918	26
April, 1915	21.5- 22	July, 1918	26
July, 1915	21.5- 22	October, 1918	24
October, 1915	21.5- 22	January, 1919	24
January, 1916	21.5- 22	April, 1919	$22 - 24
April, 1916	21.5- 22	July, 1919	22 - 24
July, 1916	21.5- 22	October, 1919	26 - 27
October, 1916	21.5- 22	January, 1920	26 - 27
January, 1917	21.5- 22	April, 1920	26 - 27
April, 1917	21.5- 22	July, 1920	26 - 27
July, 1917	21.5- 22	October, 1920	38 - 40
October, 1917	27.5		

Bones, rough, hard—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$22.5-$24	January, 1918	30 - 32
January, 1915	22.5- 24	April, 1918	30 - 32
April, 1915	22.5- 24	July, 1918	30 - 32
July, 1915	22.5- 24	October, 1918	30 - 32
October, 1915	22.5- 24	January, 1919	30
January, 1916	22.5- 24	April, 1919	28
April, 1916	22.5- 24	July, 1919	28
July, 1916	22.5- 24	October, 1919	28 - 30
October, 1916	22.5- 24	January, 1920	30 - 32
January, 1917	22.5- 24	April, 1920	30 - 32
April, 1917	26 - 27	July, 1920	80 -[1]82
July, 1917	26 - 27	October, 1920	50 - 55
October, 1917	30 - 35		

[1] Unverified, perhaps a misprint.

Blood char and bone char—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	88	Bone char	25 per cent.
1890	13	Bone char, suitable for use in decolorizing sugars	Do.
1894	9	.....do	20 per cent.
1897	10	.....do	Do.
1909	10	Bone char, suitable for use in decolorizing sugars, and blood char	Do.
1913	447	Blood char, bone char, or bone black, not suitable for use as a pigment.	Free.

Court and Treasury Decisions.

The dutiable classification of *blood char* under the name of "blood charcoal" came up under the act of 1897. The Board of General Appraisers found from the testimony that the merchandise was not the ordinary bone char of commerce, since it was made from the blood and not from the bones of animals, and that it was not commercial carbon, although carbon constituted almost two-thirds of the chemical constitution. It was held to be dutiable, not as an article composed of carbon as classified by the collection, but as bone char by similitude or as an unenumerated manufactured article which paid the same rate of duty. (G. A. 6076, T. D. 26508, of 1905.) A like conclusion was reached the next year by the Circuit Court of the Southern District of New York. The merchandise in this case was described as blood char. (United States *v.* Lueders, T. D. 27494, of 1906.) The Treasury Department acquiesced without further litigation. (T. D. 27535, of 1906.) The court decision was followed by the Board of General Appraisers in G. A. 6439, T. D. 27609, of 1906.

Many decisions have been made under the act of 1913, paragraph 447. They may be summarized as follows:

Burnt refuse pieces of ivory classified as black pigment under paragraph 53 which must be subjected to the following processes subsequent to importation: (1) Graded as to colors, (2) foreign substances such as nails and pieces of iron removed, (3) crushed to smaller sizes, (4) ground from five to eight times in a powerful mill, and (5) powdered or pulverized, were held entitled to free entry under this paragraph. (Abstract 37719, of 1915.) *Charcoal for censers* which upon examination is shown to be a mixture of charcoal and certain gummy mucilaginous substances, and which the testimony does not show is not suitable for use as a pigment, is not classable under this paragraph. Where it is intended to extend the meaning of descriptive words in a tariff law to articles not coming exactly under the specific designation by testimony, that such articles are commercially known by the terms used in the tariff law at the time of its passage, the testimony must show that the articles are uniformly and generally so known in the commerce of the entire country. (G. A. 7822, T. D. 35917, of 1915.) *Animal black* and so-called *decolorizing carbon*, classified as black pigment under paragraph 63, were claimed free of duty as charcoal or bone black under this paragraph. The protest was sustained as to the ground charred bone or animal black, but overruled as to the decolorizing carbon found to have passed beyond the stage of charcoal and held dutiable as an unenumerated manufactured article. (Abstract 37560, of 1915.) *Powdered charcoal*, classified as black pigment under paragraph 53 and claimed free of duty under paragraphs 423 and 447, was held to be a non-enumerated manufactured article and held dutiable accordingly under paragraph 385. (Abstract 38112, of 1915, following the preceding case.) In other cases merchandise variously described was held free under this paragraph as follows: *Black made from bone, ivory or vegetable substances* used for decolorizing purposes (Abstract 37347, of 1915); *ivory char* (Abstract 38789, of 1915); *burnt ivory pieces* (Abstract 38793, of 1915); *charcoal* (Abstract 39104, of 1916); *bone black* invoiced as "decolorizing powder;" *bone black* invoiced as an animal black and used as a bleaching material in the manufacture of cream of tartar and tartaric acid (Abstract 40023, of 1916). *Bone black* not suitable for use as a pigment in its condition as imported is entitled to free entry under this paragraph. (T. D. 34344, of 1914.)

CHROME PIGMENTS.

[Chrome yellow, chrome green, Par. 54, Act of 1913, 20 per cent ad valorem.]

SUMMARY.

Chrome yellow and chrome green are extremely important colors. The former is an insoluble salt made from bichromate of soda or potash and a soluble lead salt (generally lead acetate). It is prepared in a variety of shades ranging from light lemon yellow to a deep orange and differing only slightly in composition and method of manufacture. *Chrome red*, however, which is another modification of lead chromate, having almost the same chemical composition and made from the same raw materials, is classified as a vermilion red, not containing

quicksilver but containing lead, and is dutiable at 25 per cent under paragraph 59 of the tariff act of 1913. Chrome green is a mixture of chrome yellow and Prussian blue.

The United States is very nearly self-supporting as regards its supply of chrome colors. Only about 11 per cent of the consumption in 1914 was imported, and this consisted in large part of chrome green. During the war period the imports, formerly derived chiefly from Germany and England, dwindled to practically nothing.

About 75 per cent of the chrome yellow and 60 per cent of the chrome orange and chrome green produced in the United States in 1914 was made in New Jersey and New York. Illinois, which is the third largest producing State, manufactured 21 per cent of the yellow and 25 per cent of the orange and green. The total output of chrome yellow in that year was 5,747,317 pounds, valued at $641,534, and of chrome orange and chrome green (chiefly chrome orange), 8,024,409 pounds, with a value of $677,329.

About 70 per cent of the cost of chrome yellow is represented in the cost of raw materials. Under prewar and postwar conditions the raw material cost is about evenly divided between lead acetate (dutiable at 1¼ cents per pound, par. 57, act of 1913) and bichromate. Bichromate of potash, which was used before the war, is dutiable at 1 cent per pound (par. 64), while bichromate of soda, which is now the source of chromate, is dutiable at three-fourths cent per pound (par. 67). Chromium chemicals, however, are now manufactured on a large scale in this country, and it is believed that the difference between the domestic and foreign price of this item will not be much, if any, handicap to American manufacturers of chrome colors.

Chrome yellow, chrome green, etc.—Summary table.

Calendar year.	Domestic production.	Imports for consumption.	Domestic exports.	Ratio of imports to production.
	Pounds.	*Pounds.*		*Per cent.*
1910			Negligible.	
1911		154,764		
1912		202,611		
1913		103,367		
1914	13,771,726	154,933		1.125
1915		49,303		
1916		29,504		
1917		18,536		
1918		37		
1919		6,791		
1920[1]		33,098		

Calendar year.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
				Per cent.
1911	$25,089.25	$6,770.33	$0.162	27.0
1912	30,714.00	8,864.23	.151	28.9
1913	17,221.00	4,131.91	.167	24.0
1914	24,922.00	4,984.40	.161	.....
1915	9,492.00	1,898.40	.192	.....
1916	6,099.00	1,220.00	.207	.....
1917	2,420.00	484.00	.131	.....
1918	10.00	2.00	.270	20.00
1919	2,733.00	546.00	.402	20.00
1920	18,495.00	3,699.00	.555	20.00

[1] First 6 months of 1920.

GENERAL INFORMATION.

PARAGRAPH 54, ACT OF 1913.

Chrome yellow, chrome green, and all other chromium colors in the manufacture of which lead and bichromate of potash or soda are used, in pulp, dry, or ground in or mixed with oil or water, 20 per centum ad valorem.

INTRODUCTION.

The insoluble compounds formed by the interaction of bichromate of potash or soda and any soluble lead salt are extremely important pigments. When used alone a wide range of shades are possible, which vary from a very light lemon yellow through orange shades to a deep red. The yellow shades when mixed with blue pigments—almost invariably Prussian blue—yield chrome greens.

Very similar colors are obtained by adding bichromate of potash or soda to salts of zinc, but these colors are not classified with the lead compounds in the tariff laws, but come under the classification of paragraph 61 (of the act of 1913) as "pigments containing zinc, but not containing more than 5 per cent of lead" and dutiable at 10 per cent, when dry, and 15 per cent, when ground with water or oil.[1]

Similarly barium chromate, formed by the addition of the same chemicals to salts or barium, but which is not an important product, would come under paragraph 63 (act of 1913) as a color not specially provided for. Under this last paragraph or blanket clause are also imported the other chrome colors, notably chromic oxide or Guignet's green, being dutiable, therefore, at 15 per cent ad valorem (unless they are in the form of artists' colors).

DESCRIPTION.

Chrome yellow.—Normal lead chromate is a medium yellow salt, which may be produced by the simple precipitation of a soluble lead salt by means of a soluble chromate or bichromate. In order to modify the shade, however, other substances—notably lead, barium, or calcium sulphates—are mixed with the product in the grinding mill or lead sulphate may be precipitated simulataneously with the chromate. When the only diluent is lead sulphate, the product is called "pure" chrome yellow.

Chrome orange.—When chrome yellow is treated with a caustic alkali or when lead chromate is precipitated from an alkaline solution, basic lead chromate is formed. These basic chromates have an orange or red color.[1] Chemically, chrome orange is the compound, $PbCrO_4.nPbO$.

Chrome red.—Chrome red is the most basic of the lead chromates, corresponding to the formula, $Pb_2(OH)_2CrO_4$. It is sold as Persian, Derby, Victoria, Vienna, or Chinese red, or American vermilion.

Chrome green.—Chrome green is essentially a mixture of chrome yellow and Prussian blue. Generally it is also mixed with large amounts of barium sulphate or other diluent which adds to the body and cheapens the product. A wide variety of shades is possible,

[1] For an outline of the chemical structure of the various lead chromate colors, see p. 64.

ranging from a yellowish green to a very dark olive depending upon the relative proportions and the qualities of the constituent ingredients. Common proprietary names are Victoria or Prussian green, vermilion green, etc; "Satin greens" are used in litho and letter press work.

USES AND PROPERTIES.

Chrome yellow.—Chrome yellow is the most important yellow pigment for general painting. The various shades are all brilliant, mix well with oil, and have great covering power. If washed absolutely free from residual salts during the process of preparation, they are perfectly permanent as regards light,[1] but they are darkened by sulphur, either in the air or in mixed paints. For the latter reason, chrome yellow can not be blended with any pigment that contains sulphide sulphur (lithopone, ultramarine, etc.).

Chrome yellow holds an intermediate position among the yellow pigments. For the cheaper grades of outside paints, the ochers are most frequently used. Intermediate between the natural ochers and the wholly manufactured colors are the so-called golden ochers which are toned up with lead chromate. Zinc chromate is occasionally used, in spite of its higher cost, in place of chrome yellow in interior painting and, in the range of artists' colors are a number of expensive pigments that are superior to lead chromate for special purposes. The latter pigment is wholly unsuited to water-color painting.

Chrome orange.—The orange shades of paint are not so widely used as are the other shades. In general the remarks as to chrome yellow apply to the orange chrome. There is, however, a wider use of cadmium colors for producing orange shades. The other orange pigments are little used in paints. Antimony orange, although a fairly good pigment, is consumed chiefly in rubber manufacture (producing the red "antimony rubber" of commerce). Orange mineral, the lead tetraoxide pigment, is expensive and is seldom used alone as an orange color, but is frequently toned up with coal-tar dyes and sold as American vermilion.

Chrome red.—On account of the wide variety of highly satisfactory red pigments, there is little demand for the fairly expensive chrome red. It is now used only as a substitute for the costly mercury vermilion and is itself imitated by coloring white lead, orange mineral (lead), or even barytes with eosin or other coal-tar dye. Chrome red is a fairly bright red, of good body, and works well in oil. Since it is so much denser than the lighter colored chromes,[1] it has less covering power and cost much more to make. It shares the disadvantage of all lead pigments in darkening upon exposure to sulphur vapors and when ground very fine its color leans to orange.

Chrome green.—Chrome greens are the most important green pigments. Other green pigments have certain advantages for special purposes, but are more expensive and are used to a much less extent. Zinc green[2] is largely used for interior decorative purposes and for making flat wall paints, but it is much more expensive and must be

[1] Toch. Chemistry and Technology of Paints. Van Nostrand, 1916.
[2] A pigment made from zinc yellow (chromate) and Prussian blue. It is especially valuable as an artist's color.

varnished over (unless the surface is to be kept dry) as it is slightly soluble in water. Chromic oxide is the only perfectly permanent green pigment but it lacks brilliancy, is more expensive, and has weaker tinting power than chrome green. It can, however, be mixed with any pigment without decomposition, and is peculiarly adapted for the production of delicate tints in flat wall paints. It is also coming into use as a basic color in automobile painting,[1] particularly for the painting of hoods, and it is frequently used in dark green engine enamels because heat does not affect the shade. Copper and arsenic green pigments are of minor importance and green ultramarine is also seldom used for paint at the present time. Green aniline lakes, however, are becoming a somewhat important substitute for chrome green.

Chrome greens are used both in oil and water paints and in lithographic inks. They mix well in oil and have good covering power. They are fairly permanent to light but they can not be mixed with pigments containing sulphur (except sulphate sulphur) nor with alkaline substances, because of their Prussian blue content.

DOMESTIC PRODUCTION.

The only data as to the domestic production of chrome colors are for 1914. The census for that year reports an output of 5,747,317 pounds of chrome yellow, valued at $641,534. Chrome orange and chrome green are grouped together. The output in the above year was 8,024,409 pounds, valued at $677,329.

Raw materials.—The raw materials for the production of chrome yellow are: (1) Acetate or nitrate of lead and (2) potassium or sodium bichromate. The most important source of lead is the acetate salt. Lead nitrate is employed to a less extent and more rarely the sparingly soluble lead chloride is used. Of increasing importance is the use of basic carbonate white lead and this product is the chief source of lead for making chrome orange and red. Lead sulphate is occasionally used, but the lead sulphate found in many chrome pigments has been produced in the precipitation and derived from a soluble salt. In addition to the above ingredients, the production of chrome green requires Prussian blue. This color, however, is often manufactured simultaneously and its component ingredients—copperas (ferrous sulphate) and ferrocyanide of soda or potash—are the raw materials that go into the process.

The lead salts may be purchased as such or may be produced at the plant from metallic lead, basic carbonate white lead, or other lead compounds. All of these are produced in the United States from domestic ore. The prices of lead products in the United States, however, are generally slightly higher than the prices in foreign countries.

Bichromate of soda is now largely used as the source of chromium in pigment making on account of the high cost of potassium salts, especially during the war. It is not so readily transported as the more easily crystallized potash salt and is therefore frequently made at the plant from chromic iron ore and soda ash, which are fused together, leached with water, and acidified with sulphuric acid. Except during part of the war period, the chrome supply of the

[1] Toch., loc. cit.

United States has been largely imported, as the domestic deposits of this mineral are poor. The supply is ample, however, and chromium salts are produced and sold relatively cheap in the United States.

Small quantities of acids and other chemicals as well as diluents, such as barytes, are used in minor amounts as raw materials.

Process of manufacture.—The common method for preparing *chrome yellow* is simple precipitation in water solution, a solution of bichromate being added to the lead liquor.[1] In order to get the best color the lead salt should be slightly in excess, but this excess can be recovered. The precipitate is washed several times by decantation, freed from water in a filter press or in a centrifugal machine or by simply pressing in cloth bags. It is then dried at a low temperature and ground either dry or in oil. In case bichromate of potash and lead nitrate are used, potassium nitrate is recovered as a by-product from the liquor and the first wash waters.

Although the essential operations are quite simple, the manufacture of chrome yellow for the market is not an easy matter. The shade produced depends not only upon the careful mixing of the ingredients but also upon carefully regulated conditions of temperature, concentration, and stirring. The agitation, which is done by steam, is a surprisingly important matter; but even with the most skillful supervision will not result in the production of the same shades in successive batches. In order to keep up the standard grade and color of the product, blending is always necessary and this operation requires experienced workmen.

Chrome orange may be prepared in the same way as the lighter color. The difficulties attending the operation are somewhat greater because of the wider variety of shades. The essential difference in the process is that the solutions are not acid.[2] Orange shades, however, are more often made from chrome yellow which is boiled with caustic soda or quicklime until the desired shade is produced.[3] Quicklime gives a paler color than caustic soda.

Chrome red may also be prepared from chrome yellow by digestion with caustic. But it is more often made by digesting basic carbonate white lead with potassium (sodium) bichromate and caustic soda.

Chrome green may be made by either a wet or a dry process. In the latter the various ingredients (chrome yellow, Prussian blue, and barium sulphate or other diluent) are mixed in an edge runner or other paint mill. In the former the mixing is done wet by one of several methods. Most plants, however, employ a combined process, making a certain number of stock grades—say, light, medium, and dark—in three or four different qualities (i. e., more or less barytes) by a wet method and then blending them dry. The standard colors are stored dry, but not pulverized. By combining them in proper proportions, adding dry yellow or blue if necessary, any required shade can be supplied.

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[1] Lemon yellow shades are produced by the precipitation of the chromate from lead solutions acidified with an organic acid, such as citric acid (forming lead citrate, cf., p. 63). In acid solution the color range is from greenish lemon yellow to bright canary yellow, the latter being formed best in the presence of sulphuric acid.

[2] True orange is formed in a neutral solution; reddish shades in an alkaline. A basic acetate of lead is sometimes used instead of the normal acetate.

[3] The following reaction takes place (assuming complete transformation to red): $2\ PbCrO_4 + 2\ NaOH = Na_2CrO_4 + PbCrO_4.PbO.H_2O$ (i. e., $Pb_2(OH)_2CrO_4$). (The manufacture of chrome orange is described more in detail on p. 64.)

It is impossible to make a satisfactory product from a pure mixture of chrome yellow and Prussian blue in the dry process, because of the difficulty of grinding the blue. The presence of barytes helps to effect the mechanical distribution of the blue, but the dry process has such serious disadvantages that it can never be used as the exclusive process for making chrome green.

The wet process, as practiced at a few plants, is a purely mechanical operation. Prepared yellow and prepared Prussian blue are ground separately in water and mixed wet. A more general practice is to precipitate chrome yellow of the desired shade, wash out the soluble salts, and then instead of removing the product from the vat add soluble Prussian blue and barytes with stirring. Finally the mixture is filtered and dried, very much as in the preparation of the yellow pigment. A still more common method is to actually manufacture both the ingredients in the same vat. Prepared solutions of copperas and lead acetate are mixed. A certain proportion of barytes is frequently added and kept in suspension by stirring actively. A solution containing both ferrocyanide and bichromate is added to precipitate both the yellow and blue simultaneously. After a few moments stirring, the green precipitate is washed by decantation, filtered, pressed, and dried. This last method yields the most intimate mixture and fairly uniform shades.

Organization.—Practically all of the manufacturers of chrome colors make other dry colors as well. The equipment is quite similar to that required in making Prussian blue and other precipitated products and requires a rather large equipment in the way of vats, stirring devices, filtering, washing, and mixing machinery. Steam is also necessary for stirring and heating solutions.

Localities of production.—The 1914 census reports 15 establishments engaged in the manufacture of chrome yellow and 14 establishments engaged in the manufacture of chrome orange and chrome green. The industry is concentrated in the vicinity of New York City. New Jersey is the State reporting the greatest number of establishments (five) and also the largest output. New York is second. Illinois comes third. The data for 1914 show that New Jersey and New York together produced 75 per cent of the total output of chrome yellow in the United States and about 60 per cent of the orange and green. Illinois manufactured 21 per cent of the yellow and 25 per cent of the orange and green.

Domestic production and consumption.—The United States has been more nearly self-sufficient as regards its supply of chrome colors than in the case of any other important chemically manufactured pigment except white lead, zinc white, and lithopone.

IMPORTS.

The imports of chrome colors have never been large. The average annual imports for the five years[1] immediately preceding the outbreak of the war in Europe (1910 to 1914, inclusive) were only 151,447 pounds, valued at $24,418. During the war period they fell off greatly, and even in 1914, before the war but after the slight reduction of the duty under the tariff act of 1913, the imports decreased. In 1918 only 1,310 pounds, with a declared value of $439, were imported.

[1] All the references under this topic are to fiscal years.

The largest importations recorded—at least since 1894—are for the years 1902 and 1903.[1] In 1902 the imports amounted to 281,778 pounds, valued at $43,214, and in 1903, although the quantity was a few pounds less, the value was $44,218. The former year was also the year in which the maximum revenue was collected.

At the specific rate of 4½ cents per pound under the act of 1897 the duties amounted to $12,608.03. Since that date the total revenue has rarely exceeded $7,000 and has generally been less than $5,000 annually.

England is the chief country of origin of imported chrome yellow. In 1914 smaller amounts were imported from France and Germany. Germany, however, supplied most of the chrome green, which is a much more important import than any of the other chrome colors.

PRICES.

Except during the war period there has been little difference in the prices of the three shades (light, medium, and dark) of chrome yellow, as the lead sulphate in the light shades is little cheaper than the chromate. But during the war period, due to the extraordinary increase in the cost of bichromate, there developed wide differentials and the price fluctuations largely reflected the bichromate situation which became acute in 1916. In July of that year quotations ranged between 40 and 65 cents per pound, as compared with 11 to 13 cents in 1914. Sodium bichromate was used instead of the potash salt and the bichromate market became easier; the price of the pigment in October was 25 to 29 cents. The chrome shortage in the early part of 1918 caused another increase, and a quotation of 30 to 32 cents was continued until after the signing of the armistice. In July, 1919, quotations are 24 and 25 cents per pound, or almost exactly double prewar prices.

The war market for chrome green was affected in part by the cost of chrome yellow, but the prussiate situation was the greater factor. The spread between the price of light and the price of dark grades, which in 1914 and 1915 was less than 8 cents per pound, increased to nearly 20 cents. In July, 1919, the prices of these colors ranged from 35 to 60 cents, which is slightly more than double the prewar range, with differentials of from 5 to 10 cents per pound between light and medium and an additional 10 cents between medium and dark. Much of this material, however, had been made when prussiate of soda cost 50 to 75 cents per pound, and the fact that this important raw material was selling then at 17 cents introduced some uncertainty as to the existing prices for the pigments as quoted.

TARIFF HISTORY.

Chrome yellow, chrome green, and other lead chromate colors were first mentioned in the tariff act in 1890 when they were made dutiable at the specific rate of 4½ cents per pound. Prior to that they had been imported under the act of 1883 as colors not specially enumerated and subject to a duty of 25 per cent ad valorem.

[1] These years were exceptional. The imports in 1901 were only 133,029 pounds, while in 1903 they fell off to 152,822 and in 1904 to 121,051 pounds. The imports in all the period from 1900 to 1910 fluctuated greatly from year to year.

In the act of 1894 the duty was reduced from 4½ to 3 cents per pound. This was followed by an increase of 50 per cent in the imports. The duty was again fixed at 4½ cents in the act of 1897. The increase in imports was checked temporarily but, although there were large fluctuations from year to year, the general level of imports was not affected. From 1903 to 1909, inclusive, the average importation was a trifle under 140,000 pounds annually, as compared with approximately 150,000 pounds under the act of 1894, and about 100,000 under the act of 1890.

Only a slight reduction (⅛ cent per pound) was made in the duty by the act of 1909. The statistics of imports show so great fluctuation that it is difficult to trace any effect of the tariff change.

In the act of 1913 the specific rate was changed to an ad valorem duty of 20 per cent. As can be seen from the equivalent rates on page 9, this change in the character of the duty did not greatly affect the amount. The valuation per pound was from 16 to 20 cents, so the reduction was only from 4⅜ to 3⅓ or 4 cents.

COMPETITIVE CONDITIONS.

The domestic manufacturers of chrome colors are not handicapped to any large degree by the very slightly greater cost of bichromate in the United States as compared with foreign countries. They are apparently on an even more nearly equal footing with respect to all other raw materials that go into the manufacture of chrome yellow, chrome orange, and chrome red. The raw materials represent approximately 70 per cent of the cost of the finished product. Under prewar conditions the raw material cost was almost evenly divided between the cost of lead acetate and the cost of the chromate in the case of chrome yellow containing no excess of lead. Naturally, when the normal chromate is mixed with additional lead salts, as usually happens, the cost of lead salts forms the most important item in the cost.

As regards the manufacture of chrome green, however, the domestic manufacturer is in a less advantageous position. Assuming that he can, under existing conditions, meet foreign competition in the home market for chrome yellow and orange, he has a less opportunity in the case of green because the latter color also contains Prussion blue. The manufacture of Prussian blue prior to the war was handicapped by the relatively higher cost of raw material in the United States as compared with Germany, France, and Great Britain. That this situation existed is evidenced by the fact, already referred to above, that most of the chrome colors imported into the United States have consisted of chrome green.

Chrome yellow and chrome orange and green—Production in United States—Official source

[From Federal Census.]

Year.	Quantity.	Value.
	Pounds.	
1899	(1)	(1)
1904	(1)	(1)
1909	(1)	(1)
1914	5,747,317	[2] $641,534
	8,024,409	[3] 677,329
Total		1,318,863

[1] Included with "other dry colors." [2] Chrome yellow. [3] Chrome orange and green.

Chrome yellow, chrome green, and all other chromium colors in the manufacture of which lead and bichromate of potash or soda are used, in pulp, dry, or ground in or mixed with oil or water—Imports for consumption—Revenue.

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.			*Cents.*	
1911	4½ cents per pound	154,764	$25,089.25	$6,770.33	16.2	27.0
1912	do	202,611	30,714.00	8,864.23	15.1	28.9
1913	do	103,367	17,221.00	4,131.91	16.7	24.0
1914	20 per cent	154,933	24,922.00	4,984.40	16.1	20.0
1915	do	49,303	9,492.00	1,898.40	19.2	20.0
1916	do	29,504	6,099.00	1,219.80	20.7	20.0
1917	do	18,536	2,420.00	484.00	13.1	20.0
1918	do	37	10.00	2.00	27.0	20.0
1919	do	6,791	2,733.00	546.00	40.2	20.0
1920 [1]	do	33,098	18,495.00	3,699.00	55.5	20.0

[1] First 6 months of calendar year 1920.

Chrome green—Price, cents per pound.

	Dry.		In oil, chemically pure.
	Chemically pure.	Common.	
January, 1912	17–25	3½– 5	12–16
April, 1912	17–25	3½– 5	12–16
July, 1912	17–25	3½– 5	12–16
October, 1912	17–25	3½– 5	12–16
January, 1913	17–25	3½– 5	12–16
April, 1913	17–25	3½– 5	12–16
July, 1913	17–25	3½– 5	12–16
October, 1913	17–25	3½– 5	12–16
January, 1914	17–25	3½– 5	12–16
April, 1914	17–25	3½– 5	12–16
July, 1914	17–25	3½– 5	12–16
October, 1914	22–30	3½– 5	12–16
January, 1915	22–30	3½– 5	12–16
April, 1915	22–30	3½– 5	12–16
July, 1915	26–30	5– 7	36–45
October, 1915	23–32	5– 7	36–45
January, 1916	30–40	7– 9	36–45
April, 1916	80–85	18–20	90–95
July, 1916	55–75	13–18	30–75
October, 1916	40–65	9–13	70
January, 1917	40–65	9–13	70
April, 1917	32–50	8–10	70
July, 1917	32–50	8–10	70
October, 1917	32–50	8–10	70

Chrome green—Price, cents per pound—Continued.

	Light.	Medium.	Dark.	Chemically pure.	Commercial, 25 percent color.
January, 1918	[1] 30–50	.....	44–60	65–75	28–32
April, 1918	[1] 35–50	.....	44–60	65–75	28–32
July, 1918	[1] 40–50	.....	44–65	70–75	30–35
October, 1918	40–50	50–60	60–70	70–75	30–35
January, 1919	39–45	45–55	55–65	70–75	30–35
April, 1919	35–40	40–50	50–60	70–75	30–35
July, 1919	35–40	40–50	50–60	70–75	30–35
October, 1919	35–40	40–50	50–60	70–75	30–35
January, 1920	37–50	40–50	60	70–75	30–35
April, 1920	39–65	40–60	60	70–75	30–35
July, 1920	[1] 42–70	.....	50–75	70–75	30–35
October, 1920	42–60	44–65	45–70	70–75	30–35

[1] Light and medium.

Chrome yellow—Prices, cents per pound.

[From Oil, Paint, and Drug Reporter.]

	Light, chemically pure, ton lots.	Medium.	Dark.	In oil.
January, 1912	12 –13	.....	.....	16–20
April, 1912	12 –13	.....	.....	16–20
July, 1912	12 –13	.....	.....	16–20
October, 1912	12 –13	.....	.....	16–20
January, 1913	11 –13	.....	.....	16–20
April, 1913	11 –13	.....	.....	16–20
July, 1913	11 –13	.....	.....	16–20
October, 1913	11 –13	.....	.....	16–20
January, 1914	11 –13	.....	.....	16–20
April, 1914	11 –13	.....	.....	16–20
July, 1914	11 –13	.....	.....	16–20
October, 1914	10½–12	.....	.....	16–20
January, 1915	10½–12	.....	.....	16–20
April, 1915	10½–12	.....	.....	16–20
July, 1915	12½–14	.....	.....	22–25
October, 1915	12 –16	.....	.....	22–25
January, 1916	13 –17	.....	.....	30–40
April, 1916	40 –58	.....	.....	50–60
July, 1916	40 –66	.....	.....	50–60
October, 1916	25 –29	.....	.....	30–38
January, 1917	25 –28	.....	.....	30–38
April, 1917	24 –28	.....	.....	30–38
July, 1917	24 –30	.....	.....	30–38
October, 1917	24 –30	.....	.....	30–38
January, 1918	23 –30	.....	.....	32–40
April, 1918	24 –30	.....	.....	32–40
July, 1918	30 –32	.....	.....	38–45
October, 1918	30 –32	.....	.....	38–45
January, 1919	30 –32	.....	.....	38–45
April, 1919	25 –26	26–27	27–28	38–45
July, 1919	24	24	25	38–45
October, 1919	23	24	25	38–45
January, 1920	26 –28	26–28	26–28	38–45
April, 1920	28 –30	28–30	28–30	38–45
July, 1920	35	35	35	38–45
October, 1920	29	29	29	38–45

Chrome colors, etc.—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883....	87	Colors and paints, including lakes, whether dry or mixed, or ground with water or oil, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890....	53	Chrome yellow, chrome green, and all other chromium colors in which lead and bichromate of potash or soda are component parts, dry, or ground in or mixed with oil.	4½ cents per pound.
		In pulp or mixed with water, 4½ cents per pound on the material contained therein when dry.	Do.
1894....	41	Chrome yellow, chrome green, and all other chromium colors in which lead and bichromate of potash or soda are component parts, dry or ground in or mixed with oil, or in pulp or mixed with water, 3 cents per pound on the material contained therein when dry.	3 cents per pound.
1897....	48	Chrome yellow, chrome green, and all other chromium colors in the manufacture of which lead and bichromate of potash or soda are used, in pulp, dry, or ground in or mixed with oil or water.	4½ cents per pound.
1909....	46	Chrome yellow, chrome green, and all other chromium colors in the manufacture of which lead and bichromate of potash or soda are used, in pulp, dry, or ground in or mixed with oil or water.	4⅛ cents per pound.
1913....	54	Chrome yellow, chrome green, and all other chromium colors in the manufacture of which lead and bichromate of potash or soda are used, in pulp, dry, or ground in or mixed with oil or water.	20 per cent ad valorem.

COURT AND TREASURY DECISIONS.

A green paint composed of sesquioxide of chromium was held dutiable as chrome green (G. A. 1621, T. D. 13200, of 1892), so was so-called Blaugrun or Guignet's green, a dark bluish-green pigment in the condition of paste (G. A. 4591; T. D. 21720, of 1899), but oxide of chromium containing no lead or potassium bichromate, classified as chrome green, was held dutiable as a color (Abstract 37081; T. D. 35020, of 1914).

MISCELLANEOUS.

CHEMICAL STRUCTURE OF THE CHROME COLORS.

Light chrome yellow.—(1) $PbSO_4 : PbCrO_4$; (2) $2PbCO_3 : Pb(OH)_2 : PbCrO_4$; (3) lead citrate–$PbCrO_4$; (4) lead tartrate–$PbCrO_4$.

Medium chrome yellow.—$PbCrO_4$ (neutral lead chromate).

Orange chrome yellow.—$PbCrO_4$–n PbO (wherein n is any number less than 1).

Chrome red.—As above but wherein n equals 1, and also containing water of constitution. Hence the formula: $Pb_2(OH)_2CrO_4$.

PHYSICAL QUALITIES OF THE CHROME COLORS.

The chrome colors differ even more markedly in their physical qualities than they do in their chemical constitution. The two extremes are (1) a slimy light yellow precipitate absolutely devoid of crystalline structure and (2) a dense, highly crystalline red precipitate. Practically every variation between these two extremes is possible. This physical as well as chemical variation is a very important complication in the process of manufacture of the chrome colors in solution. Any mechanical operation that assists in the formation of an amorphous precipitate tends to make light shades and vice versa.

For example, in the direct process of making chrome orange (i. e., precipitation from solution), a darker shade will be produced from the same proportions of the several reagents, if (1) the solutions are at a boiling temperature; (2) the solutions are comparatively concentrated; (3) the solutions are mixed with a minimum amount of stirring (agitation); and (4) the precipitate is left in the mother liquor for digestion.

MANUFACTURE OF CHROME ORANGE.

In the preparation of chrome orange according to the reaction—

$$2PbCrO_4 + 2NaOH = PbCrO_4 \cdot PbO \cdot H_2O + Na_2CrO_4$$

the sodium chromate formed is difficult to remove from the darkened product. It is very tenaciously retained, even after repeated washing. The difficulty is, therefore, obviated in many plants by using a chrome yellow containing definite amounts of lead sulphate. The final products in this case will be (1) basic lead chromate (orange chrome), as before, and (2) sodium sulphate instead of chromate. The latter is easily washed out of the product and can be run to waste. The end reaction may be expressed as follows:

$$PbCrO_4 \cdot PbSO_4 + 2NaOH = PbCrO_4 \cdot PbO \cdot H_2O + Na_2SO_4$$

The above process is somewhat more expensive than the one based upon the direct production from basic lead acetate with chromate of soda or potash, and the results are more advantageous. The orange chrome obtained is much brighter and exhibits a very smooth and compact fracture and relatively high covering power—properties that are not invariably found in commercial chromes. By adjusting the relative amounts of lead sulphate, chromate, and alkali, shades from the palest yellow to the darkest red can be obtained. No equipment is required beyond that necessary for the production of chrome yellow. The process is not attended by any special difficulties in operation. During the digestion process steam is used for both heating and stirring.

SUBSTANCES MIXED WITH LEAD CHROMATE.

In addition to the lead salts shown in the tabulation on the preceding page other substances are added to the lead chrome colors. The lead salts, since they are necessary for the productiou of certain shades, can not be called adulterants. Other adjuncts, however, are generally added with a view of reducing the cost of production. The lighter shades of chrome can hold a surprising quantity of filler without the shade being affected in the least. Barytes, gypsum, and china clay are the usual "adulterants." Diatomaceous earth (calcined) is occasionally employed. When lead sulphate is the only extender the colors are termed "chemically pure." The darker chromes, because of their more crystalline nature, do not permit the addition of such large amounts of these inert extenders without impairing the color.

These adulterants can be and usually are added to the vat liquor immediately after the precipitation of the chromate and are thoroughly incorporated with the color during the washing, filtering, drying, and grinding of the product. The only exception to this is gypsum, which would react with the excess lead acetate.

The adulterated chromes are sold under various names, such as American yellow, Paris yellow, Baltimore yellow, new yellow, etc., and are sold at lower prices than the "pure" chromes.

LEAD CHROMATE FROM ORE-HEARTH FUME.[1]

Ore-hearth fume which contains about 55 per cent $PbSO_4$, 44 per cent PbO, 0.1 per cent ZnO, and traces of iron, is ground with caustic soda, the mixture being fed with water into a double cone continuous ball mill (Hardinge?) which has a small feed and a large discharge opening. The hydration of the soda furnishes enough heat to render the solution hot. The overflow from the mill is collected in a tank which receives the amount of acetic or nitric acid theoretically necessary to form a basic salt. Water is added for dilution and, finally, sodium or potassium chromate (or bichromate). The cost of producing 100 pounds of lead chromate by this method, using burnt fume at 2.5 cents per pound, is given as $6.68. The same process applied to litharge at 5.5 cents per pound results in a cost of $8.25 per 100 pounds of product.

OCHER AND OCHERY EARTHS.

[Par. 55, Act of 1913, 5 per cent ad valorem.]

SUMMARY.

Ocher or ochery earth is a naturally occuring mineral pigment composed largely of clay permeated with hydrated iron (ferric) oxide. Irs color ranges from yellow through orange to reddish brown, depending largely on the amount of iron present. The two grades recognized on the market are "French" and "domestic." Its most extensive use is as a filler in linoleum and oilcloth, and is also used in tinting paints. Inferior grades are used as a base for color lakes.

Domestic production (two-thirds of which is from the Cartersville (Ga.) district) supplies at least two-thirds of the consumption in this country, which is between 20,000 and 25,000 tons a year. Many of the domestic ocher mining operations are of a temporary character. There is a growing tendency, however, for large paint makers to mine their own supplies.

The imports prior to the war were between 8,000 and 9,000 tons annually and consisted chiefly of the washed and ground product. The imported product is as a rule of higher quality than the domestic. The domestic ocher could be made equal in quality to the French ocher by proper care in preparation. France is the largest producer of ocher. The production in the United Kingdom is about equal to that in the United States. A certain quantity of French ocher will be imported regardless of tariff duties because of its superiority over the domestic product. Domestic resources are ample to supply requirements of the cheaper grades.

The price of powdered French ocher prior to the war was from $35 to $45 per ton at New York. The domestic product was selling at this time at about $10 per ton. Prices for the domestic ocher reached a maximum of $30 to $60 in April, 1918, while the price of French ocher did not show a marked increase until in 1917.

[1] L. S. Hughes—Jl. Ind. and Eng. Chem. IV (1912), p. 62, and Min. and Eng. World, XXXVI (1912), p. 901.

The act of 1894 placed all dry ocher, whether crude or ground, on the Free List. The acts of 1897 and 1909 made ocher dutiable at the same rates, with the duty depending on whether it was in the crude form or whether ground and washed. The duties were changed to ad valorem by the act of 1913, and resulted in a decrease ofa bout 10 per cent for crude and about 35 per cent for the ground and washed ocher.

Ocher and ochery earths—Summary table.

Calendar year.	Domestic production.	Imports for consumption.	Ratio to production—Imports.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
	Short tons.	*Short tons.*	*Per cent.*				*Per cent.*
1910	11,711	6,021	51.4	$131,846	.....	$21.85	.....
1911	11,703	5,617	48.0	110,932	$41,904.95	19.70	37.9
1912	15,269	8,019	52.6	148,306	59,329.59	18.50	40.4
1913	17,578	8,349	47.5	143,720	47,778.95	17.20	33.3
1914	14,387	11,033	76.8	141,704	7,085.20	12.85	5.0
1915	.....	8,770	.....	137,823	6,891.15	15.70	5.0
1916	.....	9,106	.....	181,153	9,057.65	19.85	5.0
1917	.....	7,507	.....	234,490	11,724.50	31.20	5.0
1918	.....	4,161	.....	193,647	9,682.35	47.10	5.0
1919	.....	4,569	.....	219,805	10,990.00	48.10	5.0
1920[1]	.....	4,834	.....	143,904	7,195.00	29.83	5.0

[1] Six months.

General Information.

PARAGRAPH 55, TARIFF ACT OF 1913.

"*Ocher and ochery earths*, sienna and sienna earths, and umber and umber earths, 5 per centum ad valorem; * * * ."

DESCRIPTION.

Ocher or ochre is a natural mineral pigment with a decided golden-yellow color. Its composition is largely clay permeated by hydrated iron (ferric) oxide which accounts for its color. There is a wide variation in the different grades on the market. Some of the material sold in the ground form as ocher actually is ground shale or slate.

Ocher grades into sienna, which differs from ocher in that it generally contains more ferric iron than clay and its nature is such that when finely ground it is more of a stain than a pigment. Sienna also generally contains some manganese and with increased manganese content itself grades into umber.

Cream ochre contains as low as 5 per cent of iron hydroxide. It is used to some extent as a primer on wood, but has little value.

Gray ochre is silica, clay, and carbonaceous matter. Sometimes it is colored slightly green by a trace of ferrous hydroxide. It is used as a filler for cheap paint.

White ochre is nothing but ordinary clay and has no value in paint, although occasionally used as an adulterant.

Golden ochre is ochre which has been toned up with some chrome yellow. Various shades are sold. Perfect orange colored shades contain as much as 12 to 15 per cent of chrome yellow. The base may be either French or domestic ochre.

Green ochre is similar in composition to gray ochre, except that it contains a larger proportion of ferrous hydroxide. It is found principally in Bohemia and goes by the name of terre verte. It has no hiding power when used alone in paints, but as it has a high absorbent capacity for certain aniline colors, it is largely used as a base for cheap lakes. Verona green, Veronese earth, green-earth, etc., are similar products.

Red ochre is obtained by calcining raw ocher at a low red heat so as to drive off a part of the combined water. The shade depends upon the time of heating and the iron content—the longer the calcination the more purple the product. Burnt ochers are sold as Indian red, Venetian red, light red, etc. As a rule, however, these ochers are much richer in iron [1] than the ordinary ocher and are described under "iron oxides" in another unit of this series. Impure hematite also goes by the name of red ocher but is not an important pigment.

USES.

The most extensive use of ocher is as a filler of linoleum. It is also used as a pigment in tinted paints. Paints made from it are frequently used as priming coats.

SUBSTITUTES.

Ocher is the cheapest of the common yellow pigments and competes, especially in the golden grades, with more expensive products like chrome and zinc yellows. Hence it has no substitutes (in the sense of cheaper products), although some metallurgical by-products (e. g. alum sludge, etc.) of somewhat similar composition are used locally, replacing natural ocher, as are also ground shale and slate.

DOMESTIC PRODUCTION.

Localities.—Ocher is regularly produced in Georgia, Pennsylvania, Virginia, Alabama, California, Iowa, and Vermont (the States being named in order of importance). Deposits have been found in other States but are not known to have maintained any important production.

Nearly two-thirds of the total domestic output comes from the vicinity of Cartersville, Barstow County, Ga. About one-fourth of the total is produced in Berks, Lehigh, and Northampton Counties, Pa. Recently opened deposits in Florida may be an important source of supply.[2] (Based on work of the U. S. Bureau of Mines.)

Methods of production.—Ocher deposits are worked by open cut if they lie 15 feet or less below the surface. Below that depth shafts are necessary. Since the deposits are rarely large, expensive equipment is not warranted. Timber is used in minimum amounts, so that most of the mines fill up soon after active mining ceases.

The ore as mined is mixed with clay, limonite (iron ore) nodules, and pieces of chert. The clay can not be separated from the ocher, but the hard particles are removed in log washers in which the material is agitated and kept suspended in water. The overflow from the

[1] Ordinary ocher rarely contains more than 30 per cent ferric hydrate.
[2] For descriptions of various systems see "The mineral pigments of Pennsylvania." B. L. Miller. Report of the Topographical and Geological Survey Com. of Pa., No. 4. 1911. Pp. 11–43.

log washers is run into settling troughs where the sands and coarser particles separate out. Finally the overflow from these troughs goes to settling ponds. As there are several of these, a rough classification is effected, a different grade being obtained from each pond.

When the ponds are filled the water is allowed to evaporate until the material can be shoveled into wheelbarrows. It is then taken to sheds where it is dried by steam or air. At some properties the dried lump is shipped to be ground by the consumer. Other mines are equipped with burr mills and ship only the powdered product packed in barrels.

Organization.—Most of the operations are of a temporary, sporadic character. There is a growing tendency, however, for the large paint makers to mine their own supplies rather than depend upon small, irregular producers.

Production and consumption.—On account of the short life of many of the operations, estimates of production of ochers in the United States are necessarily only approximate. None at all have been published since 1914. The marketed production in that year was given by the United States Geological Survey as 14,387 short tons, valued at $136,185, which was 18 per cent more in quantity and 22 per cent less in value than the record production of 1913, although slightly greater than the average for the preceding five years.

The normal imports, prior to the entrance of the United States into the war, were 8,000 to 9,000 tons annually. These figures indicate that the normal consumption is between 20,000 and 25,000 tons a year, of which fully two-thirds is produced in this country

Exports.—There are no records available of any crude ocher being exported from the United States, although some of the paint exported to various countries undoubtedly contains ocher produced from American mines.

FOREIGN PRODUCTION.

France is the largest producer of paint ocher in the world. England and the United States are of about equal importance. Germany and Canada have each furnished considerable supplies, the former from deposits in Bavaria and Saxony. Smaller amounts are reported from Belgium, Spain, and other countries.

IMPORTS INTO THE UNITED STATES.

Since the tariff act of 1913, the Department of Commerce has not published separate statistics for imports of crude, washed, and powdered, and ocher ground in oil. These three classifications appear in the imports for consumption prior to October 3, 1913.

At no time has any large amount of ocher been imported in the crude state and only small amounts of material ground in oil. The intermediate product, consisting of washed (cleaned) and powdered material, has been the chief article imported. It is marketed in this country as "French" ocher. According to Pickrell [1] only about 14 per cent of the ocher imported in that year came from France, whereas 61.5 per cent came from England and 24.3 per cent from

[1] Pickrell, Dr. E. R., Chemicals and Allied Products used in the United States, Dept. of Commerce, Misc. Series No. 82.

Germany. It is probable, however, that all of it was of French origin and was reexported from the other countries—perhaps after being powdered and barreled.

As noted above,[1] about one third of the domestic consumption is imported. The imported product is of a different quality than the bulk of the domestic product and sells at a higher price. The competitive feature is complicated by the general prejudice in the trade as to the relative merits of the foreign and domestic ochers. Toch,[2] however, makes the following comparisons:

"In color, the French ochers are more brilliant . . . but the American ochers are invariably finer, but this, of course, refers only to the American grades of equal price."

PRICES.

The average price of American ocher before the outbreak of the European War was a little less than $10 per ton.[3] The price of the grades of French ocher imported at that time was quoted at from $35 to $45 per ton, powdered f. o. b. New York. If the cost of pulverizing is taken at about $5 these figures indicate that the French ocher was valued at from two to three times the value of the American product. The average dutiable value of imports of crude and of pulverized, etc., but not including ocher ground in oil or water, during the period beginning July 1, 1907, and ending October 3, 1913 (under the tariff acts of 1897 and 1909), was $17.38 per ton. A significant fact is that the average dutiable value of the "crude" imported during this same period was $20.40, as compared with $17.33 for "powdered, washed, or pulverized."

The high prices obtaining for the imported ochers indicate that the grades are by no means comparable with the domestic output. It is stated in Tariff Hearings[4] that the lower grades of French oxide cost $6 per ton in France, but it is evident that little, if any, of this material was being shipped to the United States.

After the outbreak of the European War, the prices of French ochers in this country showed no increase until July, 1915, when quotations advanced one-fourth cent (12 to 14 per cent) per pound. Nearly a year later (April, 1916) another one-fourth cent. Not until after the United States entered the war was there any very marked increase in the price of imported ocher. In the latter half of 1917, however, the price increased rapidly from 3 cents to 5 cents per pound for the lower grades and from 3¼ to 5½ for the better grades. The highest quotations were approximately twice the prewar quotations.

Domestic ocher, on the other hand, showed much greater price advances, especially the best grades. The quotation of $12–$16 per ton which prevailed during 1914 advanced slightly in the latter half of 1915, and again in the spring of 1916. Another advance in the summer of 1916 brought the price to $20–$30. In July, 1917, the quotation was $24–$30. Prices then remained steady until early in 1918, when the shortage of coal (paints and pigments were on the nonessential list of the War Industries Board) and difficulties of transportation became serious handicaps to the industry. Scarcity

[1] See Domestic Production and Consumption.
[2] Chemistry and Technology of Paints. 2nd Edition, Van Nostrand Co. 1916.
[3] As reported by the producers to the U. S. Geological Survey. Quoted prices ranged up to $16 and averaged something less than $12 at New York.
[4] See under miscellaneous, p. 75.

of foreign supplies was reflected in a better demand for the domestic product, and the quotations advanced to $30–$60 per ton in April, 1918. Early in 1919, domestic "strong" was selling at 3–3¼ cents per pound and "medium" at $30–$60. Prices of the latter, however, were shaded in April to $30–$40.

TARIFF HISTORY.

Dry ocher and ochery earths, both crude and powdered and washed, were placed on the free list in the act of 1894; the product ground in oil was dutiable at 1¼ cents per pound. In the act of 1897, dry ochers were again made dutiable. The feature of this act was the division of crude ocher from the powdered and washed material. The former was dutiable at one-eighth cent per pound and the latter at three-eighths cent per pound, a margin of one-fourth cent per pound ($5 per ton) to the American paint grinder working on imported material. The duty on ocher in oil was increased to 1½ cents per pound.

The rates of the act of 1897 were continued in 1909 except that the margin on ocher in oil was reduced to 1 cent without noticeable effect on the imports, which continued to fall off. In 1913 ad valorem duties were adopted and all ochers were made dutiable at 5 per cent. The result, based upon the dutiable value of the imports of the preceding year, was a reduction in the duty on crude, from over 16 per cent ad valorem to 5 per cent, a decrease of $1.50 per ton. In the case of powdered or washed material, the reduction was much greater, as the three-eighths cent duty for several years had been equivalent to more than 40 per cent. The duty on ocher in oil was reduced a little more than that on crude, viz, from between 17 and 20 per cent to 5 per cent.

The lower grades of French foreign ocher had never been imported into the United States even in powdered form. Unwashed crude of the cheap grades contains too much waste material to bear transportation charges to any great distance from the point of production. The duty of three-eighths cent per pound on washed or powdered ocher amounted to practically 100 per cent of the value of the cheaper products and served to exclude all but the high-grade material. The act of 1913 swept away the barrier on low grades, since the ad valorem rate took account only of the value without regard to the degree of manufacture. The import statistics for 1914 and 1915 reflect this situation. Although these statistics include all classes of ocher—even that ground in oil—the average dutiable value was less than in any previous years.

COMPETITIVE CONDITIONS.

A certain amount of French ocher will be imported under any circumstances because of its superior color as compared with the domestic product. Domestic mines, however, are able to meet the requirements of the country for the cheaper grades almost indefinitely, provided an adequate price can be secured for the product. American resources are ample and can be made available with little if any greater effort than foreign deposits.

In the case of the earth colors, labor constitutes over 75 per cent of the cost of production.[1] The situation, therefore, is different in

[1] Various statements in tariff hearings and elsewhere. See p. 75.

the case of ocher and the other natural pigments from the case of pigments manufactured in factories by chemical processes. In the latter the cost of the raw material is the important item, but these relatively cheap natural products derive their value chiefly from the work of extracting them from the ground and preparing them for market. Both of these operations call for a large amount of labor and there is little opportunity for adding to the effectiveness of the individual by better machinery or improved methods.

Ocher production in United States.

[From Mineral Resources, pt. 2. Production not reported since 1914.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1900	17,015	$186,707	1911	11,703	$109,465
1904	16,826	110,602	1912	15,269	149,289
1909	14,310	137,880	1913	17,578	173,944
1910	11,711	112,445	1914	14,387	136,185

Ocher, sienna, umber, and metallic paints.

PRODUCTION IN UNITED STATES—"OFFICIAL SOURCE."

[From Federal Census, "Iron, buff, and other earth colors."]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1899	17,452	$367,987	1909	106,643	$1,085,438
1904	24,413	336,616	1914	46,448	797,819

PRODUCTION IN UNITED STATES—"OTHER SOURCES."

[From Mineral Resources, U. S. Geol. Survey (until 1914). Production not reported since 1914.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1909	34,456	$360,726	1912	44,421	$352,616
1910	42,148	324,014	1913	48,452	365,998
1911	38,307	316,853	1914	46,124	336,908

Ocher—Production in United States.

[From Geological Survey, Mineral Resources, pt. 2.]

State.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
California	118	$1,730	(1)	(1)	(1)	(1)
Georgia	7,011	70,388	7,395	$69,447	10,107	$101,790
Pennsylvania	3,642	32,254	3,013	28,101	3,300	28,950
Vermont	609	5,935	(1)	(1)	531	6,346
Other States [2]	331	2,138	1,295	11,917	1,331	12,203
Total	11,711	112,445	11,703	109,465	15,269	149,289

[1] Included in "Other States."
[2] 1910, Iowa, Kentucky, Oregon, and Tennessee; 1911, California, Iowa, Vermont, and Virginia; 1912, California, Iowa, and Virginia.

Ocher—Production in United States—Continued.

State.	1913		1914	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
California	(1)	(1)	(1)	(1)
Georgia	11,420	$123,090	8,607	$84,193
Pennsylvania	3,935	32,175	3,799	34,223
Vermont	(1)	(1)	(1)	(1)
Other States [2]	2,223	18,679	1,981	17,769
Total	17,578	173,944	14,387	136,185

[1] Included in "Other States."
[2] 1913 and 1914, Alabama, California, Iowa, Vermont, and Virginia.

Ocher and umber—Production in principal foreign countries.[1]

Country.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United Kingdom [2]	18,271	$73,873	18,497	$74,832	16,335	$66,827
France [3]	36,971	419,321	36,232	428,238	38,075	313,276
Germany [4]	2,554	5,859	3,038	6,404	3,434	10,324
Canada [3]	3,940	28,093	4,813	33,185	3,622	28,333
Belgium [3]	771	1,351	661	1,158	595	965
Spain [3]	461	813	837	1,442	686	1,200
Cyprus [5]	3,781	20,011	3,441	15,748	4,221	15,850

Ocher and umber—Production in principal foreign countries.[1]

Country.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
United Kingdom [2]	15,621	$66,481	16,951	$70,370
France [3]	46,087	420,248	[6] 61,993	.....
Germany [4]	7,668	14,072	.....	.....
Canada [3]	7,654	32,410	5,987	41,771
Belgium [3]	716	1,592	.....	.....
Spain [3]	661	1,168	.....	.....
Cyprus [5]	5,259	20,945	.....	.....

[1] Mineral Resources, U. S. Geological Survey. No data after 1913.
[2] Includes oxides of iron and manganese used for pigments, etc.
[3] Reported as ocher only.
[4] Bavaria and Saxony.
[5] Exports of umber.
[6] Statistique de l'Industrie Minerale.

Ocher and ochery earths—Imports for consumption—Revenue.

Fiscal year.	Rate of duty per pound.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910:						
Crude, not powdered, washed, or pulverized.	¼ cent per pound..	100,421	$1,391	$125.00	$0.014	9.02
Powdered, washed or pulverized.	⅜ cent per pound..	15,266,164	122,189	57,248.00	.008	46.85
Ground in oil or water	1 cent per pound..	14,413	767	144.00	.053	18.78
1911:						
Crude	¼ cent per pound..	213,435	2,579	266.80	.012	10.35
Powdered	⅜ cent per pound..	13,295,207	118,759	49,857.01	.009	41.98
Ground	1 cent per pound..	10,609	547	106.09	.052	19.39
1912:						
Crude	¼ cent per pound..	42,814	904	53.51	.021	5.92
Powdered	⅜ cent per pound..	11,687,021	109,494	43,826.31	.009	40.03
Ground	1 cent per pound..	16,346	901	163.46	.055	18.14
1913:						
Crude	¼ cent per pound..	433,595	4,506	541.99	.01	12.03
Powdered	⅜ cent per pound..	17,149,677	157,881	64,311.27	.009	40.73
Ground	1 cent per pound..	16,988	970	169.88	.057	17.51
1914:						
Crude	¼ cent per pound..	43,288	327	54.11	.008	16.51
Powdered	⅜ cent per pound..	4,685,576	39,631	17,570.90	.008	44.34
1914	5 per cent [2]	16,913,112	114,589	5,729.45	.007	5.00
1915	do	17,430,228	124,359	6,217.95	.007	5.00
1916	do	18,049,375	153,880	7,694.00	.009	5.00
1917	do	17,873,109	213,272	10,663.60	.012	5.00
1918	do	7,087,555	130,655	6,532.75	.0184	5.00

[1] Old law, July 1 to Oct. 3, 1913. [2] New law, Oct. 4, 1913, to June 30, 1914.

Ocher and ochery earths, n. s. p. f.—Imports for consumption—Revenue.

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910:						
Crude, not powdered, washed or pulverized.	¼ cent per pound..	181,176	$2,055.00	(?)	$0.0113	(?)
Powdered, washed or pulverized.	⅜ cent per pound..	11,849,921	129,308.00	(?)	.0109	(?)
Ground in oil or water	1 cent per pound..	10,213	483.00	$102.13	.0474	21.1
1911:						
Crude, not powdered, washed or pulverized.	¼ cent per pound..	128,328	1,870.00	160.41	.0146	8.57
Powdered, washed or pulverized.	⅜ cent per pound..	11,090,798	108,205.00	41,590.48	.0097	38.5
Ground in oil or water	1 cent per pound..	15,406	857.00	154.06	.0557	18.0
1912:						
Crude, not powdered, washed or pulverized.	¼ cent per pound..	160,117	1,884.00	200.14	.0117	10.6
Powdered, washed or pulverized.	⅜ cent per pound..	15,863,678	145,699.00	59,488.76	.0092	40.7
Ground in oil or water	1 cent per pound..	14,069	723.00	140.69	.0513	19.5
1913: [1]						
Crude, not powdered, washed or pulverized.	¼ cent per pound..	321,671	3,282.00	402.09	.0102	12.3
Powdered, washed or pulverized.	⅜ cent per pound..	12,126,238	104,212.00	45,473.38	.0086	43.8
Ground in oil or water	1 cent per pound..	13,068	770.00	130.68	.0588	17.0
1913 [2]	5 per cent	4,236,121	35,456.00	1,772.80	.0084	5.0
914	do	22,066,006	141,704.00	7,085.20	.0064	5.0
1915	do	17,540,671	137,823.00	6,891.15	.0079	5.0
1916	do	18,212,051	181,153.00	9,057.65	.0100	5.0
1917	do	15,014,293	234,490.00	11,724.50	.0156	5.0
1918	do	8,321,892	193,647.00	9,682.35	.0232	5.0
1919	do	9,137,187	219,805.00	10,990.00	.0240	5.0
1920 (first 6 months)	do	9,667,889	143,904.00	7,195.00	.0148	5.0

[1] Jan. 1 to Oct. 3, 1913. [2] Oct. 4 to Dec. 31, 1913.

Ocher and ochery earths, prices (wholesale) spot, New York market.

[From Oil, Paint and Drug Reporter.]

Kind or grade.	Dry, French, per pound.	In oil, French, per pound.	Golden, imported, per pound.	Domestic.		
				Golden.		Strong, per ton.
				Per ton.	Per pound.	
	Cents.	*Cents.*	*Cents.*		*Cents.*	
January, 1912	1½–2	6– 8	3 – 4	$12–$15	4–5	.....
April, 1912	1½–2	6– 8	3 – 4	12– 15	4–5	.....
July, 1912	1½–2	6– 8	3 – 4	12– 15	4–5	.....
October, 1912	1½–2	6– 8	3 – 4	12– 15	4–5	.....
January, 1913	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
April, 1913	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
July, 1913	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
October, 1913	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
January, 1914	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
April, 1914	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
July, 1914	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
October, 1914	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
January, 1915	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
April, 1915	1½–2½	6– 8	3 – 4	12– 16	4–5	.....
July, 1915	2 –2½	8–10	3 – 4	14– 20	4–5	.....
October, 1915	2 –2½	8–10	3 – 4	14– 20	4–5	.....
January, 1916	2 –2½	8–10	3 – 4	14– 20	4–5	.....
April, 1916	2½–3	8–10	4½– 5½	18– 26	5–6	.....
July, 1916	2½–3	8–10	4½– 5½	20– 30	6–8	.....
October, 1916	2½–3	11–13	4½– 5½	20– 30	6–8	.....
January, 1917	2½–3	11–13	4½– 5½	20– 30	6–8	.....
April, 1917	3 –3½	11–13	5 – 6	20– 30	6–8	.....
July, 1917	3 –3½	11–13	5 – 6	20– 30	6–8	.....
October, 1917	4½–5	11–13	5 – 6	24– 30	6–8	.....
	Superior.			*High grade.*	*Medium, per ton.*	
January, 1918	5 –5½	15–18	5 – 6	6– 8	$24–$30	$30–$36
April, 1918	5 –5½	15–18	5 – 6	6– 8	24– 30	30– 60
						Per pound, cents.
July, 1918	Nominal.	15–18	5 –10	6– 10	30– 60	3 –4
October, 1918	Nominal.	15–18	5 –10	6– 10	30– 60	3 –4
January, 1919	Nominal.	15–16	5 –10	5– 10	30– 60	3 –3½
April, 1919	Nominal.	15–16	5 –10	5– 10	30– 40	3 –3½
July, 1919	Nominal.	18–22½	5 –10	5– 10	20– 40	3 –3½
October, 1919	Nominal.	18–22½	5 –10	5– 10	30– 40	2½
January, 1920	5 –6½	18–22½	5 –10	5– 10	30– 40	2½
April, 1920	5 –6½	18–22½	4½– 8½	2½	30– 40	2½
July, 1920	5 –6½	18–22½	4½– 8½	2½	30– 40	2
October, 1920	4½–5	18–22½	6 – 7	.....	30– 55	3 –5

Ocher and ochery earth—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	89	Ocher and ochery earths, umber and umber earths, and sienna and sienna earths, when dry.	½ cent per pound.
		When ground in oil	1½ cents per pound.
1890	54	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, not specially provided for in this act, dry.	½ cent per pound.
		Ground in oil	1½ cents per pound.
1894	42	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, ground in oil.	1½ cents per pound.
1894	566	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, not specially provided for in this act, dry.	Free.
1897	49	Ocher and ochery earths, sienna and sienna earths, and umber and umber earths, not specially provided for, when crude or not powdered, washed, or pulverized.	½ cent per pound.
		If powdered, washed, or pulverized	⅝ cent per pound.
		If ground in oil or water	1½ cents per pound.
1909	47	Ocher and ochery earths, sienna and sienna earths, and umber and umber earths, not specially provided for in this section, when crude or not powdered, washed, or pulverized.	½ cent per pound.
		If powdered, washed, or pulverized	⅝ cent per pound.
		If ground in oil or water	1 cent per pound.
1913	55	Ocher and ochery earths, sienna and sienna earths, and umber and umber earths.	5 per cent ad valorem.

COURT AND TREASURY DECISIONS.

Venitian red is a dry paint and not ochery earth. (G. A. 629, T. D. 11346, of 1891.)

A calcareous earth, colored by ferric oxides of a red color and similar in appearance to red hemitites, was held dutiable as ochery earth and not as clay. (G. A. 1880, T. D. 13608, of 1892.)

Burnt ocher was held dutiable as ochery earth and not as a color. (G. A. 2478, T. D. 14756, of 1894.)

Those decisions were under the act of 1890.

It was declared not necessary that an importation should have been subjected to all three of the operations, "powdered, washed, or pulverized," in order to come within the provision, and it is immaterial whether the process of washing be natural or artificial. (G. A. 5631, T. D. 25170, of 1904.)

Crude burnt sienna was held dutiable at one-eighth of a cent per pound. Crude sienna and powdered sienna were distinguished as follows: "Powdered or pulverized sienna has a tendency to cake or form lumps, but the lumps are easily crushed with the fingers, and the resulting mass is soft and smooth to the touch and of a uniform color. Lumps of crude sienna are less friable, contain more or less grit, and the inside of a lump is of a deeper color than the outside." (G. A. 4489, T. D. 21403, of 1899.)

Freedom from grit was declared to indicate that the earth is not crude and ocher pulverized and washed was held dutiable at three-eighths of a cent per pound. (G. A. 4455, T. D. 21263, of 1899.)

These decisions were under the act of 1897.

A red pigment imported to be used as a color and filler, found not to be an ochery earth and not commercially known as an ocher, was held dutiable as a color under the act of 1894. (Vandegrift *v.* United States, 107 Fed., 265, of 1900.)

MISCELLANEOUS.

TARIFF HEARINGS.

The following data are taken from a brief presented by Geo. S. Mepham Co. (Tariff Schedules. United States Senate. 63d Cong., 1913, p. 149):

"In the United States in 1911, the wages per day in this industry were $1.75 for the commonest labor and $3 for skilled labor. Similar figures for France were 2 francs ($0.40) and 2.50 francs ($0.50).

"The cost of the cheaper grades of French ocher at the factory in Apt, Vaucleuse was $6 per ton in that year. Freight to seaboard was $2 a ton, and from Marseilles to New York $3 a ton more. The cost f. o. b. New York was thus $11 a ton. But this price was slightly greater than that determined by the active competition of the American producers among themselves. However, only the cheapest domestic grades could be produced at that price, and mines in the Eastern States, where the freight to market was low, were practically the only ones that could operate at even a small profit.

"These figures indicate that the domestic producers were practically independent of the tariff on the cheapest grades, but the difference in cost of producing the more expensive grades, where selection of material, with consequently larger labor cost, as well as

deposits that can supply the better material, is requisite, is much greater. American producers were unable to produce these grades until better prices prevailed because of the cutting off of ocean shipment during the war period."

Data pertaining directly to the ocher industry are not at present available, but costs of producing manganese ore, whose occurrence is roughly comparable to that of ocher and which is partly produced in the same localities, indicate that the cost in the winter of 1918–19 must be at least $20 per ton for mining and freight. Increases in the cost of pulverizing are also possible, so it is quite probable that the cost of production in the United States has fully doubled since 1914.

Brief of J. Lee Smith & Co., New York City. (Tariff hearings, House of Representatives, 60th Cong., p. 454). Protest against the proposed incorporation of paragraph 49 with paragraph 58. In round figures the result would be a reduction on ocher of about 51 per cent, an increase in duty on umber of about 40 per cent, and an increase in the duty on sienna of about 81 per cent. The result would be a great advantage to sellers of American sienna but a serious injustice to American ocher miners. The bulk of the ocher imported is in powdered form and the American miners are dependent upon the duty of three-eighths cent per pound to market their product. With regard to umber, the quality of American product is very poor and most of the umber used is imported and originates in the island of Cyprus. Few mines in the United States produce a good sienna, and the finer grades, which are used principally for staining wood in imitation of oak, mahogany, etc., must be imported and powdered here ready for use (We have a mill in Brooklyn for powdering crude earths and object to having the duties increased on umber and sienna for the benefit of one manufacturer in Philadelphia.)

J. W. Coulston & Co., of New York City (Ibid., p. 454), petitioned that the word "washed" be omitted from the first part of the paragraph (which refers to crude earths). They import sienna earths from Italy. The goods are in lumps which have been naturally washed or are in such condition that they do not need to be washed. In some instances, however, it has been classified (graded by water settling), and they are obliged to pay a duty of three-eighths cent per pound (instead of the one-eighth cent intended for crude) in spite of the fact that the material must be pulverized. The material in question can not be used by paint manufacturers in the same manner as the goods classified at three-eighths cent per pound, so that the present wording results in the classification of these few sienna earths that are sufficiently washed by nature at three-eighths cent, with no benefit to consumers.

F. A. Reichard, after a canvass of the paint manufacturers of the country, submitted the following recommendation:

"We ask that these earth paints be entered free of duty, as nothing of the kind suitable for paint making has ever been found in this country. American mines produce much lower grades, suitable only for jobbing, so it is quite evident that the tariff in this instance is a tax, pure and simple, and not in any sense a protection.

"For instance the average declaration value of foreign ochers (1902–1906, inclusive) was $19.275 per 2,000 pounds, and the average value of the American ochers (1902–1906, inclusive) was $8.59 per 2,000 pounds.

"Thus at a glance it is seen that the tariff plays no part in fixing the price of American ochers. In this contention we are supported by 49 out of 54 grinders who replied, and of the 5 desiring a duty 3 suggest lowering the present rate."

Again in 1913, Mr. Reichard expressed the same views (Tariff Hearings, House of Rep., 62d Cong., p. 307): "There are no qualities suitable for paint manufacturers, which branch of the country's industries is the largest user of these colors produced in this country. It is readily apparent, therefore, that the three-eighths cent per pound duty is unjust, * * *. So long as suitable quantities are not produced here, we think the manufacturer and the ultimate consumer should receive the benefit of free entry. The few American mines produce vastly inferior grades and really do not enter into competition with the imported products to any appreciable degree."

J. W. Coulston & Co., of New York, protested against the proposed reduction of duties on powdered sienna, ocher, and umber resulting from the adoption of the ad valorem rate as compared with the old specific rates. In their judgment there should be a difference of $5 per ton between the powdered and the unground product, whereas the flat ad valorem rate of 5 per cent results in a difference of only about $1.

J. Lee Smith & Co., of New York, stated that: "It costs abroad an average of 52 cents to powder 100 pounds of these materials, and in this country $1.06. This results in that it costs 54 cents more to do the work here, on account of the high cost of labor, etc., than it does to do the work in Europe, whereas the new tariff allows less than 3 cents per 100 pounds. To equalize the higher cost of manufacturing in this country there should be at least an ad valorem duty of 25 per cent on the powdered goods if the crude goods are to pay an ad valorem duty of 5 per cent."

UMBER AND SIENNA.

[Par. 55, act of 1913, 5 per cent ad valorem.]

SUMMARY.

Umber and sienna are forms of rust-stained clay, very similar to ocher in composition, but containing more or less manganese and having, therefore, a darker yellow or brown color. Siennas are translucent and have more the nature of a stain than a pigment; the color is lighter than that of umber. Both umber and sienna are used raw, but the burnt pigments, which are darker, are more important colors. Burnt sienna is reddish brown while burnt umber is a rich warm brown.

Deposits of umber and sienna are widely distributed in the United States, but the demands of the trade are for special shades and qualities which can be produced more cheaply in foreign countries. Italian sienna and Turkish (Cyprus) umber are standard colors throughout the civilized world. It is practically impossible to duplicate these shades as cheaply by selection of domestic material as by importation. Most of the paint factories that consume these articles are located in the Eastern States where supplies from Mediterranean ports can, in normal times, be transported almost wholly by water.

Statistics of domestic production have not been gathered since 1914, but it is doubtful if there has been any considerable increase.

The average output of domestic umber and sienna before the war was less than 1,000 tons annually. The bulk of the consumption is imported. The imports of umber of all classes in 1914 amounted to 2,303 short tons, valued at $35,570; the imports of sienna in the same year were 3,245 tons with a value of $55,925.

Three forms of these pigments are imported: (1) Crude or unpulverized, (2) powdered or washed, and (3) paste (ground in water or oil). Imports of paste have been relatively unimportant. Most of the importation has been in crude form. The specific duties under the tariff act of 1909 allowed a protection of $5 per ton more on the powdered or washed material than on untreated material. The adoption of the ad valorem duty in 1913 resulted in the reduction of this differential to only a trifle more than $1 per ton.

Umber and sienna [1]*—Summary table.* [2]

Calendar year.	Domestic production.	Imports for consumption.	Ratio to production—imports.	Value (imports for consumption).	Amount of duty	Value per unit of quantity, per short ton.	Equivalent ad valorem rate.
	Short tons.	*Short tons.*	*Per cent.*				*Per cent.*
1910	1,015	3,530	348	$76,872	[3]	$21.79	.....
1911	1,005	3,012	299	59,331	$10,968.03	19.70	18.5
1912	805	3,961	493	77,420	14,255.24	19.52	18.4
1913	776	4,255	548	85,306	12,831.37	20.04	15.1
1914	790	7,851	994	109,238	5,461.70	14.11	5.0
1915	.....	5,970	.....	97,465	4,873.25	16.32	5.0
1916	.....	7,472	.....	152,469	7,623.45	20.40	5.0
1917	.....	3,489	.....	99,950	4,997.50	28.68	5.0
1918 [4]	.....	1,698	.....	80,151	4,007.55	47.20	5.0
1919 [4]	.....	1,243	.....	60,013	3,000.65	48.28	5.0
1918	.....	1,064	.....	74,013	3,700.65	69.56	.....
1919	.....	2,025	.....	69,378	3,468.90	34.26	.....
1920 [5]	.....	2,321	.....	82,912	4,145.60	35.72	.....

[1] All classes combined.
[2] No statistics for domestic exports.
[3] No data.
[4] Fiscal years.
[5] Six months ending June 30, 1920.

General Information.

PARAGRAPH 55, TARIFF ACT OF 1913.

"Ocher and ochery earths, *sienna and sienna earths*, and *umber and umber earths*, 5 per centum ad valorem; * * *."

DESCRIPTION.

Both umber and sienna are natural pigments consisting essentially of clay colored by hydrated oxides of iron and manganese. Minor constituents, such as excess silica, lime, and other matter, may also be present. The composition is very similar to that of ocher although they invariably contain manganese and frequently more iron. The presence of manganese accounts for their browner color.

Sienna most nearly approaches ocher in chemical composition and the chief distinction is its physical character. It is translucent rather than opaque and is more of a stain than a pigment, whereas ocher is a true pigment. Similarly burnt sienna, a reddish-brown product obtained by calcining raw sienna, differs from certain iron oxide pigments because of its relative transparency.

Umber contains more manganese than sienna. The brown color is much deeper and even the burnt product does not approach red. Umber is much coarser than sienna, but the coarse particles are broken up in calcining.

Umber and sienna are marketed both raw and burnt. The burnt pigments are more important. They are marketed in the form of cubes, corrugated tablets, and as powder. One of the commonest forms is a soft pulp from which most of the water has been expelled, but which is still moist.

Raw sienna (Terra di Siena, Italian earth) is a brown tinted pigment used for oil, water color, tempera, and fresco painting.

American burnt sienna is a reddish-brown pigment containing rom 25 to 60 per cent iron oxide (Fe_2O_3). One grade, found in Pennsylvania, assays as high as 80 per cent ferric oxide and is known as double strength sienna. This is richer and deeper than the Italian sienna, and when reduced with ordinary clay and ground in oil makes a staining pigment equal to the Italian.[1]

Italian burnt sienna.—This pigment generally contains more iron than the American product, averaging from 60 to 75 per cent iron oxide (Fe_2O_3). American pigments of the same iron content differ materially in shade, having a Havana brown color whereas the Italian is more of a maroon. Italian siennas, when tinted with 20 per cent of white, show a bluish tint while American siennas yield a brownish or yellowish hue. For paint making, the best grades of either pigment are those that contain a small amount of lime. Many grinders add from 5 to 10 per cent of whiting (lime carbonate) to umbers and siennas to prevent them from running or disintegrating when used as staining colors.

Raw umber (Turkey umber, Levant umber, Terra ombra, etc.). This pigment is similar in many respects to raw sienna except that it is much coarser and contains a considerable proportion of the higher oxides of manganese. The color is greenish to yellowish brown.

Burnt umber.—All umbers contain over 5 per cent of manganese dioxide. The color is much richer and warmer than that of the raw umber. Turkey umbers usually contain more manganese and iron than the American. Products rich in manganese when calcined yield brighter shades in proportion to the fineness to which they have been powdered or to the care bestowed on their levigation. The specially bright burnt umbers are put on the market as "velvet brown, chestnut brown, manganese velvet brown," etc. Occasionally brands very similar to colcothar (iron oxide) are marked as such.

USES.

Umbers and siennas have much the same physical properties as ocher, except their color, which is darker. Both products are used principally in paints. They are very permanent, have good covering power, mix well with all other pigments without alteration, are not affected by acids or alkalies, and are cheap.[2]

Ground sienna is largely used for lithographic and typographic printing and as an artists' color—either alone or as a base for lake

[1] Toch. Paint Technology and Tests. Van Nostrand Co., 1916.
[2] Thorp. Outlines of Industrial Chemistry. MacMillan Co., 1916.

pigments upon which organic coloring matters are precipitated from solution.[1] There is a wide use of sienna as a stain and colored filler for wood that is to be varnished. In mixed paints, siennas are used largely for their tinting quality, the resulting shade being a yellowish maroon or salmon color.

Umber has similar uses in paints but has greater covering power. It yields very durable varnish paints that dry very quickly and hard. Umber is an essential ingredient of weather-proof paints and gives an unusual variety of colors for house painting. A considerable quantity of umber is consumed in the wall-paper industry to produce the ground shade.

SUBSTITUTES.

Siennas are the most expensive of the common brown pigments, but the range in quality is such that the lower grades are cheaper than many of the substitutes. Of these Cassel brown or Vandyke brown—a natural earth containing a variable amount of organic matter—is probably the most important. The various iron oxides (metallic paints) are also used largely. Brown lakes—except those having sienna, umber, or ocher as a base—are not used to any considerable extent as substitutes for these important pigments.

DOMESTIC PRODUCTION.

Neither umber nor sienna has been produced in any large amount in the United States. Production statistics were gathered by the Geological Survey for several years but were discontinued in 1914. On account of the small amount of production, both products were combined. As shown by these data, the maximum output was in 1909, when 1,276 short tons, valued at $33,472, was produced. Since 1910, the total production has not exceeded 1,000 tons for any one year.

Localities.—Practically the only production of umber and sienna comes from Pennsylvania. Deposits have been reported in other States, but have never supplied any appreciable quantity of the pigments.

Methods of production.—The mining and preparation of umber and sienna are quite similar to the methods used for ochre. Labor is the most important item in the cost of production of the lower grades; but on special grades, control of a deposit of a much desired quality and color, is an important factor in determining the price that can be obtained for the product.

Domestic production and consumption.—While the United States is independent as regards a sufficient supply of both umber and sienna, so far as available quantities are concerned, it must import certain qualities and shades of color.

In 1914, the last year for which complete data are available, the combined imports of umber and sienna were 7,581 short tons, valued at $109,238, as compared with a domestic output (as reported to the Geological Survey) of only 790 short tons, valued at $21,070. Assuming that the consumption was the sum of the two quantities

[1] A popular lake of this kind is mahogany ("Cashew") lake used for lithographic and letter-press printing.

(i. e., neglecting stocks), it is evident that the domestic mines produced only a little more than 9 per cent of the quantity and 16 per cent of the value of the United States consumption in that year. Some slight improvement from these figures is to be expected during the war period because of the difficulty of ocean shipment and the enhanced prices that obtained for these pigments. But it is apparent that this country is still largely dependent on foreign supplies of many of the more popular shades of umber and sienna.

Domestic exports.—So far as can be determined, there are no exports of either umber or sienna from the United States except in mixed paints; in many of which they are important constituents.

FOREIGN PRODUCTION.

Umber is found in practically all countries, but specially fine qualities are produced in Cyprus, Sicily, Asia Minor, and the Netherlands. German deposits also have yielded considerable quantities. Turkish umber, produced chiefly in Cyprus, is the world standard on this pigment and dominates the markets of all countries, although the production in Sicily is almost as large and of good quality.

Italian sienna, produced in Tuscany, enjoys the same preeminence in its field as does Turkish umber in the world market. The Harz Mountains are the only other important source of supply, although small amounts are produced in many parts of the world.[1]

The Italian production of sienna and umber is highly centralized. According to a statement in Tariff Schedules[2] one firm in Leghorn was shipping practically 90 per cent of the material exported to the United States in 1911 and 1912.

IMPORTS.

Prior to October 3, 1913, the Department of Commerce, following the tariff classifications, divided the imports of umber and of sienna into three classes, viz: (1) Crude, not washed, powdered or pulverized; (2) powdered, washed or pulverized; and (3) ground in oil or water. After that date, however, no such division has been observed. Statistics of all three classes of each product have been grouped together.

The imports of umber and of sienna ground in oil have never been large, and, as far as the statistics extend, were decreasing. Only once (1910) in 25 years has the value of imports of umber in oil exceeded $500 in any one year. Imports of sienna in oil have fluctuated more or less, but in this period have never exceeded $1,000 in value for any one year, and as a rule were less than $500.

Both pigments have been imported largely in the crude form, although, prior to 1905, the imports of powdered sienna exceeded those of crude sienna. While there has been a little fluctuation from year to year the imports have shown a fairly steady increase. Imports of powdered sienna and umber also register a pronounced increase, though much less rapid than in the case of the crude (at least prior to the adoption of the 1913 tariff schedule).

[1] Spanish brown—an important pigment mined in Spain—is sometimes classed as umber, but is rather a metallic paint (iron oxide).
[2] U. S. Senate, 62d Congress, 1913, p. 156.

The countries of origin of the imports of pigments are not published by the Department of Commerce. A compilation of the imports in 1914, made by Dr. Pickrell of that department, however, shows that 47.3 per cent of the sienna imported in that year came from France, 31.8 per cent from Italy, and 20.9 per cent from Germany. Italy furnished 45.8 per cent of the umber imported, Malta 34.8 per cent, Great Britain 16 per cent, Germany 1.4 per cent, and only 0.9 per cent direct from Cyprus. These figures indicate a considerable amount of reexporting. In the case of crude, this reexporting may be explained partly by indirect trade routes because of the comparatively small tonnages involved. In the case of "powdered," much of the material has been shipped to northern Europe in the crude state and there prepared for market by washing and grinding.

The increased importations of umber and umber earths, together with the effects of the tariff change of 1913, are brought out in the table presented on page 84. As soon as the new rates went into effect the imports of umber increased very rapidly. Imports of sienna also increased, but somewhat more slowly. Even the difficulty of ocean shipment failed to check the rapid rise until the restrictions of the Shipping Board practically prevented further movement of these commodities after the United States entered the war.

The revenue collected by the Government, however, was reduced under the operation of the new schedule. Comparing the figures for the fiscal year 1913 (the last year under the old rates) with the maximum imports in later years, we find that, in 1915 the revenue collected on sienna, amounting in 1913 to $9,696.55, was cut to one-third of its former amount in spite of a small increase in the amount and an increase of 50 per cent in the value, due partly to higher prices but especially to increased receipts of powdered as compared with crude. Similarly in the case of umber the revenue collected in 1917 was less than one-half that received in 1913 although the amount imported in the later year was almost two and a half times as great.

PRICES.

Spot prices of the various grades of umber and sienna in the New York market, during the war period, will be found on page 86. These quotations show surprisingly slight advances as compared with the extraordinary rise of general pigment prices since the outbreak of the war. In very few instances has the advance exceeded 50 per cent and only in the case of the highest grade of imported product has there been an increase of 100 per cent. As compared with the large advances in ocher recorded during the same period, the domestic product especially remained practically steady, whereas the price of imported grades did not rise anything like as much as might be expected by reason of the difficulties of Mediterranean shipment.

TARIFF HISTORY.

The tariff history of sienna and umber is identical with that of ocher. Nearly all of the statements in tariff hearings with reference to umber and sienna apply with equal force to ocher. For these

reasons, it does not seem advisable to duplicate this material and reference is made to the survey on ocher for tariff history and digest of tariff questions.

COMPETITIVE CONDITIONS.

The competitive status of the domestic umber and sienna industries presents features quite similar to those of the ocher industry. Broadly speaking, it may be said that the domestic production of umber and sienna is even more handicapped by the preference for the foreign shades than is the case with ocher. The domestic producer is handicapped by the larger wages he has to pay, since fully 75 per cent of the cost of production of the powdered pigments is expended for labor.[1] He does have a slight advantage, as compared with the shippers from Mediterranean ports, in the cost of transportation. Nearly all the earth pigments are consumed in factories located in the eastern States so the advantage as *regards transportation applies only to the present producers in the State of Pennsylvania.* The development of deposits known to exist in localities more distant from the points of consumption is hindered by the cost of railroad freight.

The factor of cost, however, is subordinate. Turkey umber and Italian sienna would be imported almost regardless of price because of their more desirable color. The prices of the imported grades invariably rule higher than those of the domestic grades.

On the other hand, assuming the necessity of importing more or less of the material, there arises the question as to whether this is to be imported in the crude state or whether it is to be imported in powdered form ready for mixing with oil. (Competition, at least in the home market, is not to be expected for pigments in oil.)

Prior to the tariff act of 1913, there was a differential of $5 per ton (one-fourth cent per pound) given the washing and pulverizing treatment. (Since the duty on crude was one-eighth cent, while that on "powdered" was three-eighths cent.) The placing of all grades on an ad valorem basis cut this differential to about $1 per ton, in the case of either raw or burnt umber, and from 55 cents to $1.50 ($2 for the highest grades) on siennas.

Umber and sienna—Production in United States.

[From Mineral Resources, part 2.]

	Short tons.	Value.		Short tons.	Value.
1900	[2] 2,409	$41,698	1911	1,005	$26,225
1904	522	12,960	1912	805	21,975
1909	1,276	33,472	1913	776	20,790
1910	1,015	26,700	1914	790	21,070

[1] Various statements in tariff hearings and elsewhere. [2] Exceptional output (1,452 tons) of umber.

Sienna and sienna earth, n. s. p. f.—Imports for consumption—Revenue.

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910:						
Crude, not powdered, washed, or pulverized.	½ cent per pound..	3,048,203	$46,866	.....	$0.0154	.....
Powdered, washed, or pulverized.	¾ cent per pound..					
Ground in oil or water...	1 cent per pound..	6,233	453	$62.33	.0726	13.8
1911:						
Crude, not powdered, washed, or pulverized.	½ cent per pound..	2,181,300	25,807	2,726.62	.0118	10.6
Powdered, washed, or pulverized.	¾ cent per pound..	707,065	11,188	2,651.49	.0158	23.7
Ground in oil or water...	1 cent per pound..	9,927	667	99.27	.0672	14.9
1912:						
Crude, not powdered, washed. or pulverized.	½ cent per pound..	2,171,758	29,892	2,714.72	.0138	9.07
Powdered, washed, or pulverized.	¾ cent per pound..	884,306	15,462	3,316.15	.0176	21.5
Ground in oil or water...	1 cent per pound..	6,021	440	60.21	.0730	13.7
1913:[1]						
Crude, not powdered, washed, or pulverized.	½ cent per pound..	1,637,593	22,737	2,046.99	.0138	9.03
Powdered, washed, or pulverized.	¾ cent per pound..	730,370	12,056	2,738.90	.0166	22.6
Ground in oil or water...	1 cent per pound..	2,502	92	25.02	.0368	27.2
1913[2]	5 per cent.....	902,752	13,650	682.50	.0152	5.0
1914	.....do.....	7,815,323	63,958	3,197.90	.0082	5.0
1915	.....do.....	6,105,515	65,283	3,264.15	.0107	5.0
1916	.....do.....	4,537,999	82,999	4,149.95	.0183	5.0
1917	.....do.....	2,643,748	57,330	2,866.50	.0217	5.0
1918	.....do.....	1,641,214	60,154	3,007.70	.0366	5.0
1919	.....do.....	1,734,807	46,134	2,306.70	.0265	5.0
1920[3]	.....do.....	1,768,817	53,438	2,671.90	.03002	5.0

[1] Jan. 1 to Oct. 3, 1913. [2] Oct. 4 to Dec. 31, 1913. [3] Six months.

Umber and umber earths—Imports for consumption—Revenue.

CALENDAR YEAR.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910:						
Crude, not powdered, washed, or pulverized.	½ cent per pound..	3,994,286	$28,819	$4,993.00	$0.0072	17.32
Ground in oil or water..	1 cent per pound..	11,813	734	118.13	.0622	16.3
1911:						
Crude, not powdered, washed, or pulverized.	½ cent per pound..	2,504,976	12,624	3,131.24	.00503	24.8
Powdered, washed, or pulverized.	¾ cent per pound..	616,211	8,702	2,310.78	.0141	26.6
Ground in oil or water..	1 cent per pound..	4,863	343	48.63	.0705	14.2
1912:						
Crude, not powdered, washed, or pulverized.	½ cent per pound..	4,033,610	19,584	5,042.02	.00486	25.8
Powdered, washed, or pulverized.	¾ cent per pound..	824,096	11,824	3,090.35	.0143	26.2
Ground in oil or water..	1 cent per pound..	3,179	218	31.79	.0684	14.6
1913:[1]						
Crude, not powdered, washed, or pulverized.	½ cent per pound..	3,993,669	23,752	4,992.11	.00596	21.0
Powdered, washed, or pulverized.	¾ cent per pound..	543,836	7,724	2,039.38	.0142	26.4
Ground in oil or water..	1 cent per pound..	6,042	374	60.42	.0619	16.2
1913[2]	5 per cent.....	692,942	4,921	246.05	.0071	5.0
1914	.....do.....	7,886,716	45,280	2,263.80	.0058	5.0
1915	.....do.....	5,835,292	32,182	1,609.10	.0055	5.0
1916	.....do.....	10,405,923	69,470	3,473.50	.0067	5.0
1917	.....do.....	4,334,394	42,620	2,131.00	.0098	5.0
1918	.....do.....	487,623	13,859	692.95	.0284	5.0
1919	.....do.....	2,315,377	23,244	1,162.00	.....	5.0
1920[3]	.....do.....	2,872,247	29,474	1,473.70	.....	5.0

[1] Jan. 1 to Oct. 3, 1913. [2] Oct. 3 to Dec. 31, 1913. [3] Six months ending June 30, 1920.

Umber and umber earths—Imports for consumption—Revenue—Continued.

FISCAL YEAR.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910:						
Crude, not washed, powdered, or pulverized.	¼ cent per pound..	3,235,771	$19,429	$4,044.71	$0.006	20.82
Powdered, washed, or pulverized.	¾ cent per pound..	845,793	12,271	3,171.96	.015	25.84
Ground in oil or water..	1 cent per pound...	7,687	426	76.87	.054	18.04
1911:						
Crude, not washed, powdered, or pulverized.	¼ cent per pound..	2,557,313	13,265	3,196.66	.005	24.10
Powdered, washed, or pulverized.	¾ cent per pound..	492,331	6,372	1,846.21	.013	28.99
Ground in oil or water..	1 cent per pound..	6,789	444	67.89	.064	15.29
1912:						
Crude, not washed, powdered, or pulverized.	¼ cent per pound..	2,962,166	13,377	3,702.72	.005	27.68
Powdered, washed, or pulverized.	¾ cent per pound..	762,772	11,283	2,860.39	.015	25.35
Ground in oil or water..	1 cent per pound..	5,463	399	54.63	.073	13.69
1913:						
Crude, not washed, powdered, or pulverized.	¼ cent per pound..	5,256,077	29,391	6,570.12	.006	22.35
Powdered, washed, or pulverized.	¾ cent per pound..	817,500	11,217	3,065.60	.014	27.33
Ground in oil or water..	1 cent per pound..	6,083	380	60.83	.062	16.01
1914:[4]						
Crude, not washed, powdered, or pulverized.	¼ cent per pound..	1,069,059	7,138	1,336.33	.007	18.72
Powdered, washed, or pulverized.	¾ cent per pound..	151,713	2,478	568.93	.016	22.96
Ground in oil or water..	1 cent per pound..	2,538	156	25.38	.061	16.03
1914[5]	5 per cent	3,381,919	25,798	1,289.90	.008	5.00
1915	do	7,225,537	36,128	1,806.20	.005	5.00
1916	do	8,914,389	55,076	2,753.80	.006	5.00
1917	do	9,211,112	66,217	3,310.85	.007	5.00
1918	do	665,195	18,850	942.50	.028	5.00
1919	do	425,017	11,776	588.80	.028	5.00

[4] Old law July 1 to Oct. 3, 1913. [5] New law Oct. 4 to June 30, 1914.

Sienna and sienna earths—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910:						
Crude, not powdered, washed, or pulverized.	¼ cent per pound..	1,891,216	$25,139	$2,364.03	$0.013	9.21
Powdered, washed, or pulverized.	¾ cent per pound..	1,020,570	17,741	3,827.11	.017	21.58
Ground in oil or water.	1½ cents per pound.	2,224	144	33.36	.065	23.16
	1 cent per pound..	5,556	390	55.56	.070	14.25
1911:						
Crude, not powdered, washed, or pulverized.	¼ cent per pound..	1,961,225	26,091	2,451.52	.013	9.40
Powdered, washed, or pulverized.	¾ cent per pound...	879,939	15,961	3,299.78	.018	20.67
Ground in oil or water..	1 cent per pound..	9,853	643	98.53	.065	15.32
1912:						
Crude, not powdered, washed, or pulverized.	¼ cent per pound..	1,996,761	23,369	2,495.96	.012	10.68
Powdered, washed, or pulverized.	¾ cent per pound..	776,839	12,658	2,913.13	.016	23.01
Ground in oil or water..	1 cent per pound..	751	87	7.51	.116	8.63
1913:						
Crude, not powdered, washed, or pulverized.	¼ cent per pound..	2,898,638	38,982	3,623.32	.013	9.29
Powdered, washed, or pulverized.	¾ cent per pound..	1,056,542	17,874	3,962.06	.017	22.17
Ground in oil or water..	1 cent per pound..	7,421	502	74.21	.068	14.79

Sienna and sienna earths—Imports for consumption—Revenue—Continued.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
1914:[1]		*Pounds.*				*Per cent.*
Crude, not powdered, washed, or pulverized.	½ cent per pound..	322,315	$5,436	$402.89	$0.017	7.39
Powdered, washed, or pulverized.	¾ cent per pound..	187,775	3,115	704.15	.017	22.69
Ground in oil or water..	1 cent per pound..	1,102	30	11.02	.027	36.67
1914	5 per cent [2]	5,979,137	47,344	2,367.20	.008	5.00
1915	do	6,656,031	64,858	3,242.90	.010	5.00
1916	do	5,206,292	83,428	4,171.00	.016	5.00
1917	do	2,990,972	61,163	3,058.15	.020	5.00
1918	do	2,731,181	61,301	3,065.05	.022	5.00
1919	do	2,060,857	48,237	2,411.85	.023	5.00

[1] Old law, July 1 to Oct. 3, 1913. [2] New law, Oct. 4, 1913, to June 30, 1914.

Umber—Dry colors, prices (wholesale or retail), per pound.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919	1920
Turkey, burnt, powdered:[1]	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	2⅛–3	3 –3½	3 –3½	3 –3½	3 –4	4 –5	4½–6½	5 –7	5 –6½
April	2⅛–3	3 –3½	3 –3½	3 –3½	3 –4	4 –5	4½–6½	5½–7	5½–7
July	2⅛–3	3 –3½	3 –3½	3 –4	4 –5	4 –5	5 –7	5 –6½	5½–7
October	2⅛–3	3 –3½	3 –3½	3 –4	4 –5	6 –7½	5 –7	5 –6½	5½–7
Burnt, lump, selected:[1]									
January	3 –4½	3 –4½	3 –4½	3 –4½	3½–5	4½–6	4½–6	5 –6	5 –6
April	3 –4½	3 –4½	3 –4½	3 –4½	3½–5	4½–6	4½–6	5½–7	5½–7
July	3 –4½	3 –4½	3 –4½	3½–5	4½–6	4½–6	5 –6	5 –6	5½–7
October	3 –4½	3 –4½	3 –4½	3½–5	4½–6	4½–6	5 –6	5 –6	.....
Raw and powdered:									
January	2⅛–3	2⅛–3	2⅛–3	2⅛–3	3 –3½	3 –3½	4½–6½	[2]	.....
April	2⅛–3	2⅛–3	2⅛–3	2⅛–3	3 –3½	3 –3½	4½–6½	[2]	.....
July	2⅛–3	2⅛–3	2⅛–3	3 –3½	3 –3½	3 –3½	[2]	[2]	.....
October	2⅛–3	2⅛–3	2⅛–3	3 –3½	3 –3½	4½–6	[2]	[2]	4½–6
Raw, in lumps:									
January	3 –4½	3 –4½	3 –4½	3 –4½	3½–5	3½–5	4 –5	[2]	.....
April	3 –4½	3 –4½	3 –4½	3 –4½	3½–5	3½–5	4 –5	[2]	.....
July	3 –4½	3 –4½	3 –4½	3½–5	3½–5	3½–5	[2]	[2]	.....
October	3 –4½	3 –4½	3 –4½	3½–5	3½–5	4 –5	[2]	[2]	6

[1] In ton lots. [2] Nominal.

Umber—Dry colors, prices (wholesale or retail) per pound—Car lots in barrels.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919	1920
American, burnt, powdered:	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	2 –2½	2 –2½	2 –2½	2 –2½	2 –2½	2 –2½	3½–4	3½–4	3½–4
April	2 –2½	2 –2½	2 –2½	2 –2½	2 –2½	2½–3	3½–4	3½–4	4½–6
July	2 –2½	2 –2½	2 –2½	2 –2½	2 –2½	2½–3	3½–4	3½–4	4½–6
October	2 –2½	2 –2½	2 –2½	2 –2½	2 –2½	4 –5	3½–4	3½–4	4½–6
Raw:									
January	2½–3	2½–3	2½–3	2½–3	2½–3	2 –2½	3 –3½	3 –3½	3 –3½
April	2½–3	2½–3	2½–3	2½–3	2½–3	2½–3	3 –3½	3 –3½	4 –5
July	2½–3	2½–3	2½–3	2½–3	2 –2½	2½–3	3 –3½	3 –3½	4 –5
October	2½–3	2½–3	2½–3	2½–3	2 –2½	4 –5	3 –3½	3 –3½	6

Umber—In oil, prices per pound in 1-pound and 5-pound cans.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919	1920
Turkey umber, burnt or raw:	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	11-14	11-14	11-14	11-14	11-14	15-21	17-23	25-27	28-30
April	11-14	11-14	11-14	11-14	15-21	15-21	17-23	25-27	28-30
July	11-14	11-14	11-14	11-14	15-21	15-21	25-27	28-30	28-30
October	11-14	11-14	11-14	11-14	15-21	15-21	25-27	28-30	28-30

Sienna—Dry colors, prices per pound in ton lots, in barrels.

[From Oil, Paint, and Drug Reporter.]

Kind or grade	1912	1913	1914	1915	1916	1917	1918	1919	1920
American, burnt and powdered:	*Cents*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	2½-3	2½-3	2½-3	2½-3	2½-3	2 -3	2 -3	2½- 4	2½- 4
April	2½-3	2½-3	2½-3	2½-3	2½-3	2 -3	2½-4	2½- 4	3½- 5
July	2½-3	2½-3	2½-3	2½-3	2½-3	2 -3	2½-4	2½- 4	4½- 7½
October	2½-3	2½-3	2½-3	2½-3	2 -3	2 -3	2½-4	2½- 4	4½- 7½
Raw:									
January	2½-3	2½-3	2½-3	2½-3	2½-3	2½-3	2½-3	2½- 3	2½- 3
April	2½-3	2½-3	2½-3	2½-3	2½-3	2½-3	2½-3	2½- 3	2½- 5
July	2½-3	2½-3	2½-3	2½-3	2½-3	2½-3	2½-3	2½- 3	4 - 7
October	2½-3	2½-3	2½-3	2½-3	2½-3	2½-3	2½-3	2½- 3	4 - 7
Raw, powdered:									
January	3 -7	4 -7	4 -4	4 -7	5 -8	4 -6	6 -8	6 - 8	6¾-12
April	3 -7	4 -7	4 -7	4 -7	5 -8	4 -6	6 -8	6¾-12	9 -14
July	3 -7	4 -7	4 -7	5 -8	4 -6	4 -6	6 -8	6¾-12	8 -14
October	3 -7	4 -7	4 -7	5 -8	4 -6	4 -6	6 -8	6¾-12	6½-15
Raw, lump:									
January	2½-3	3 -5	3 -5	3 -5	4 -6	4 -6	5 -6½	5 - 6½	5½- 7
April	2½-3	3 -5	3 -5	3 -5	4 -6	4 -6	5 -6½	5 - 6½	7 -12
July	2½-3	3 -5	3 -5	4 -6	4 -6	4 -6	5 -6½	5 - 6½	6 -12
October	2½-3	3 -5	3 -5	4 -6	4 -6	5 -6½	5 -6½	5 - 6½	.....
Burnt, lump:									
January	2½-3	3¾-6	3¾-6	3¾-6	3¾-8	4 - 6	4- 6	4 - 6	4 - 6
April	2½-3	3¾-6	3¾-6	3¾-6	3¾-6	4 - 6	4- 6	4 - 6	8 -16
July	2½-3	3¾-6	3¾-6	3¾-6	4 -6	4 - 6	4- 6	4 - 6	6 -16
October	2½-3	3¾-6	3¾-6	3¾-6	4 -6	4 - 6	4- 6	4 - 6	.....
Italian, burnt and powdered:									
January	3 -5	4 -7	4 -7	4 -5	5 -7	5½- 8	6- 8	7 -15	5½- 8
April	3 -5	4 -7	4 -7	4 -7	5 -7	5½-10	6-15	7 -15	8 -16
July	3 -5	4 -7	4 -7	5 -7	6 -8	6 -10	7-15	7 -15	6 -16
October	3 -5	4 -7	4 -7	5 -7	6 -8	6 -10	7-15	6¼-15	6½-15

Sienna, in oil, Italian, burnt or raw, best grades, prices per pound.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	12-15	12-15	12-15	12-15	12-15	16-22	18-24	26-28	30-32
April	12-15	12-15	12-15	12-15	16-22	16-22	18-24	26-28	30-32
July	12-15	12-15	12-15	12-15	16-22	16-22	26-28	30-32	30-32
October	12-15	12-15	12-15	12-15	16-22	16-22	26-28	30-32	30-32

Sienna and sienna earths, prices per pound, foreign (Italian burnt). High—low.

[From Oil, Paint, and Drug Reporter.]

	1917	1918	1919		1917	1918	1919
	Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*
January	8-5½	15-6	15-7	August	10-6	15-7	15-7
February	8-5½	15-6	15-7	September	10-6	15-7	15-7
March	10-5½	15-6	15-7	October	15-5	15-7	15-5½
April	10-5½	15-6	15-7	November	15-5	15-7	15-5½
May	10-6	15-6	15-7	December	15-6½	15-7	15-5½
June	10-6	15-6	15-7				
July	10-6	15-7	15-7	Average	15-5	15-6½	15-6⅜

Umber and umber earths, prices per pound—Foreign (high-low).

[From Oil, Paint, and Drug Reporter.]

	1917	1918	1919		1917	1918	1919
	Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*
January	5–5	6½–4½	7–5	August	5 –4	7–5	6½–5
February	5–4	6½–4½	7–5½	September	5 –4	7–5	6½–5
March	5–4	6½–4½	7–5½	October	7½–4½	7–5	6½–5
April	5–4	6½–5	7–5½	November	5 –4	7–5	6½–5
May	5–4	6½–5	7–5½	December	6½–4½	7–5	7 –5
June	5–4	7 –5	7–5½				
July	5–4	7 –5	7–5½	Average	5½–4	6¾–4¾	6½–5½

Sienna and sienna earths—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Ocher and ochery earths, umber and umber earths, and sienna and sienna earths, when dry.	½ cent per pound.
		When ground in oil	1½ cents per pound.
1890	54	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, not specially provided for in this act, dry.	½ cent per pound.
		Ground in oil	1½ cents per pound.
1894	42	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, ground in oil.	1¼ cents per pound.
1894	566	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, not specially provided for in this act, dry.	Free.
1897	49	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, not specially provided for, when crude or not powdered, washed, or pulverized.	½ cent per pound.
		If powdered, washed, or pulverized	⅝ cent per pound.
		If ground in oil	1½ cents per pound.
1909	47	Ocher and ochery earths, sienna and sienna earths, and umber and umber earths, not specially provided for in this section, when crude or not powdered, washed, or pulverized	½ cent per pound.
		If powdered, washed, or pulverized	⅝ cent per pound.
		If ground in oil or water	1 cent per pound.
1913	55	Ocher and ochery earths, sienna and sienna earths, and umber and umber earths.	5 per cent ad valorem.

Umber and umber earths—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Ocher and ochery earths, umber and umber earths, and sienna and sienna earths, when dry.	½ cent per pound.
		When ground in oil	1½ cents per pound.
1890	54	Ocher and ochery earth, sienna and sienna earths, umber and umber earths, not specially provided for in this act, dry.	½ cent per pound.
		Ground in oil	1½ cents per pound.
1894	42	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, ground in oil.	1¼ cents per pound.
1894	566	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, not specially provided for in this act, dry.	Free.
1897	49	Ocher and ochery earths, sienna and sienna earths, umber and umber earths, not specially provided for, when crude or not powdered, washed, or pulverized.	½ cent per pound.
		If powdered, washed, or pulverized	⅝ cent per pound.
		If ground in oil or water	1½ cents per pound.
1909	47	Ocher and ochery earths, sienna and sienna earths, and umber and umber earths, not specially provided for in this section, when crude or not powdered, washed, or pulverized.	½ cent per pound.
		If powdered, washed, or pulverized	⅝ cent per pound.
		If ground in oil or water	1 cent per pound.
1913	55	Ocher and ochery earths, sienna and sienna earths, and umber and umber earths.	5 per cent ad valorem.

MISCELLANEOUS.

Total imports and revenue.

SIENNA (ALL CLASSES).

Fiscal year.	Quantity.	Value.	Revenue.
	Pounds.		
1900[1]	905,956	$17,346	$3,188.59
1905	1,493,948	23,530	3,832.14
1910	2,685,795	23,476	5,276.28
1913[2]	6,079,660	40,888	9,696.55
1915[3]	6,656,031	64,858	3,242.90
1917	2,990,972	61,163	3,058.15
1918	2,731,181	61,301	3,065.05
1919	2,060,857	48,237	2,411.85

UMBER (ALL CLASSES).

	Pounds.		
1900	1,885,310	$13,169	$3,351.43
1905	2,109,557	17,542	4,240.88
1910[4]	1,927,183	30,827	4,395.65
1913[2]	3,962,601	57,358	7,659.59
1915	7,225,537	36,128	1,806.20
1917[3]	9,211,112	66,217	3,310.85
1918	665,195	18,850	942.50
1919	425,017	11,776	588.80

[1] Imports of "powdered" exceeded the imports of "crude."
[2] Last year under old rates.
[3] Maximum year.
[4] Unusually large imports of "powdered" and small amount of "crude."

IRON OXIDE PIGMENTS.

[Par. 55, act of 1913.]

GENERAL INFORMATION.

Par. 55. " * * * Spanish brown, venetian red, Indian red, and colcothar or oxide of iron, not specially provided for in this section, 10 per centum ad valorem."

DESCRIPTION.

The above provision covers a variety of brown and red paint pigments both natural and artificial, whose colors are due primarily to iron oxides or iron hydroxides. The distinction in the pigment industry, however, between iron oxides of natural origin and those obtained artificially is not sharp. Of these pigments those of the red shade are the more important. The nomenclature of these red pigments is involved and the names are descriptive of the shade rather than of origin, method of production, or chemical composition.

Venetian red is a term loosely applied to a variety of the red iron oxide pigments, varying in chemical composition. The only distinction the name implies is light red pigment in contrast to darker iron oxide pigments, chiefly Indian red. Some writers state that the produc- should be restricted to pigments composed of a mixture of iposits in and calcium sulphate, produced by neutralizing pickling ices practi- lime and calcining the residue. Under this later d- om a deposit reds contain 20 to 40 per cent of iron oxide (Fe_2O cent of calcium sulphate ($CaSO_4$). On the other

s, p. 13).

Domestic production and consumption.—The United States is the largest consumer of iron oxide paints in the world and its demands are growing. Most of the supply comes from domestic sources although the value of the domestic production only slightly exceeds the value reported for imports. This may be explained by the fact that the values of the imports are reported for more or less finished products, whereas the values of the domestic products are given in many instances for crude material.

FOREIGN PRODUCTION.[1]

Spain is one of the principal producers of iron oxide for use as a pigment. The iron oxide occurs in Spain as hematite ore and is found in unlimited quantities in eastern Andalusia. Oxide of iron is prepared for pigment use in Malaga by four firms. The ore at this place is treated by grinding, washing, and drying. Practically all of the oxide of iron is exported from Spain through the port of Malaga, which is the only large market for the product in Spain, as it is very little used elsewhere—small quantities only being sent to Barcelona and to Bilboa.

Exports of Spanish oxide of iron to the United States began about 1901, with a relatively small shipment. Since then exports have increased greatly, and in 1918 the exports of oxide of iron were 4,492,764 pounds, valued at $141,330, and of oxide of iron crude, 3,123,068 pounds, valued at $24,641. In 1919 the exports amounted to 4,333,482 pounds, valued at $139,258.

The Spanish ore contains between 80 and 90 per cent of ferric oxide. Although the high content of iron oxide may increase the quality of the oxide for rust-preventing paints, it does not influence the other qualities of the mineral paints, on which much of its value as a paint depends. For example, brilliancy of color, staining, and coloring power are not in proportion to the content of iron oxide. Oxides of iron containing low percentages of ferric oxide may be more brilliant in color and stronger in staining powers, and therefore be worth more than those with a high percentage of iron oxide.

IMPORTS INTO THE UNITED STATES.

Imports of venetian red from 1910 to 1914, inclusive, were fairly constant and averaged about 2,500,000 pounds, with a value ranging from $20,000 to $29,000. Since 1914, imports of venetian red have decreased each year to a minimum of 179,700 pounds, valued at $3,509. The dutiable value of imports was less than 1 cent per pound prior to 1917. In 1919 the dutiable value was about 2 cents per pound.

The imports of Spanish brown, Indian red, and colcothar, or oxide of iron, had increased prior to the war to $214,343—in 1914. Imports since then have ranged from $170,000 in 1915, to $340,000 in 1917. In 1919 the quantity of imports was shown for the first time and amounted to about 10,000,000 pounds, with a value slightly over $300,000, or approximately 3 cents per pound.

In 1914 imports of both venetian red and other oxides of iron were valued at about $50,000 less than the value of the domestic

[1] Abstracted from Commerce Reports, Jan. 8, 1917.

production for venetian red and metallic paints, as reported by the Geological Survey. The quantity of the domestic production was, however, much greater than the quantity of imports. Although the origin of imports is not shown in "Commerce and Navigation," Spain is probably the chief foreign source of supply, as evidenced by the imports from that country into the United States.

PRICES.

Venetian red prior to the war was quoted at about three-fourths cent per pound. In 1916 prices increased to about 2 cents per pound and from that time until 1920 prices have shown little variation.

Indian red, English, from 1912 to 1914, inclusive, was quoted at 5–7 cents per pound, while the standard American grade was quoted at 1.5–1.6 cents per pound during the same period. From 1915 to 1917, inclusive, only Indian red, standard was quoted. The price increased from 1½–5 cents per pound to 10–14 cents per pound in the latter part of 1917. From 1918 to 1920, inclusive, prices of English Indian red increased from 15 cents per pound in January, 1918, to 20 cents per pound in January, 1919. In April, 1919, the price of this grade declined sharply to 14 cents per pound, which price was in force throughout the remainder of 1919 and also in 1920. During this same period the price of standard American grade ranged from 8–14 cents per pound. The price in October, 1920, was 12 cents per pound.

Oxide red, English, from 1912 to 1914, inclusive, was quoted at 2¾–10 cents per pound, while the price of American grade was uniform at 2–7 cents per pound. During 1915–1917, inclusive, oxide red only was quoted and the price increased from 2–10 cents per pound to 4½–15 cents per pound during the last half of 1917. At the beginning of 1918, three grades of oxide red were quoted from copperas, domestic powder, and Spanish. The oxide red derived from copperas is a very high grade and from 1918 to 1920, inclusive, ranged from 12–15 cents per pound; the 15-cent price was quoted during the last half of 1920. Spanish oxide red during the same period ranged from 3½–7 cents per pound; the price in October 1920 was 5 cents per pound. The domestic-powder grade is the cheapest product and the price ranged from 2–4½ cents per pound during the same period—the price quoted during the last half of 1920 being 4½ cents per pound.

Crocus martus from 1912 to 1914, inclusive, was quoted at 1½–3½ cents per pound for the imported product, and at 1–2½ cents per pound for the standard American grade. From 1915 to 1917 inclusive, crocus martus only was quoted. The price increased from 1½ cents in 1915 to 3 cents per pound during the last three quarters of 1916 and during 1917. Beginning in 1918, two grades were quoted—standard American, and Spanish. The price of the standard American was practically constant at 4 cents per pound from 1918 to 1920, inclusive. During this period the Spanish ranged from 3½–7 cents per pound; the price in October, 1920, was 5 cents per pound.

TARIFF HISTORY AND CONSIDERATIONS.

Prior to the act of 1913, iron oxide pigments, both natural and artificial, were dutiable under general provisions for pigments n. s. p. f. The duty on such pigments in the acts of 1897 and 1909 was 30 per cent ad valorem. The act of 1913 provided for "Spanish brown, venetian red, Indian red, and colcothar or oxide of iron," at a duty of 10 per cent ad valorem.

With the exception of venetian red, imports of which decreased, this reduction of duty was followed by increased imports of the group—Spanish brown, Indian red, and colcothar or oxide of iron. The imports of these closely related pigments during 1917 to 1919 inclusive were about three times the prewar import.

The terms Spanish brown and colcothar are obsolete in present pigment trade and might well be omitted in future tariff laws. Also there is no clear demarcation in the trade between venetian red, Indian red and oxide of iron. These overlapping pigments all derive their color from iron oxides or iron hydroxides and might well be described by the general phraseology "iron oxide and iron hydroxide pigments."

Venetian red—Production in United States.

[From Mineral Resources, pt. 2.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1909	8,358	$145,733	1912	6,306	$116,511
1910	6,418	115,683	1913	6,171	116,195
1911	5,773	106,009	1914 [1]	7,445	119,895

[1] Not listed since 1914.

Metallic paints,[1] iron oxides, etc.—Production in United States.

State.	1908		1909		1910	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Maryland	[2]	[2]	431	1,957	[2]	[2]
New York	2,924	$28,090	2,533	$25,533	[3] 11,085	$32,208
Pennsylvania	5,281	69,799	[4] 8,120	105,683	8,063	91,714
Tennessee	[5] 3,645	34,663	4,075	33,369	[5] 3,907	26,680
Wisconsin					6,367	34,267
Other	2,172	24,142	5,543	35,363		
Total	14,022	156,694	20,722	201,905	29,422	184,869

[1] Include natural iron oxides, anhydrous and hydrated; roasted iron carbonate; ground blast-furnace dust; pyrite cinder or blue billy; residue from extracting bauxite with sulphuric acid in the manufacture of alum. Mortar colors are not included.
[2] Included in Tennessee.
[3] Includes other States.
[4] Includes small quantity of Venetian red.
[5] Includes Maryland.

Metallic paints, iron oxides, etc.—Production in United States—Continued.

State.	1911		1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Maryland	(1)	(1)	562	$1,930	(5)	(5)	(5)	(5)
New York	7,993	$28,569	[2] 10,951	29,547	[2] 14,949	$34,041	[2] 14,678	$33,864
Pennsylvania	7,676	100,837	8,970	107,499	8,312	106,172	9,862	121,888
Tennessee	3,282	25,381	(3)	(3)	(5)	(5)	(5)	(5)
Wisconsin	2,048	11,258	2,106	9,953	[2] 2,144	11,584	[2] 2,339	8,389
Other	4,600	15,118	5,758	32,423	4,693	19,467	4,068	15,512
Total	25,599	181,163	28,347	181,352	30,098	171,264	30,947	179,653

[1] Included in Tennessee.
[2] Principally crude iron ore sold for paint.
[3] Includes other States.
[4] Includes Maryland.
[5] Included in other States.

Venetian red—Imports for consumption—Revenue.

Calendar year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	30 per cent	2,490,138	$21,591	$6,477.00	$0.866	30.0
1911	do	2,194,823	20,169	6,050.70	.922	30.0
1912	do	2,828,627	22,916	6,874.80	.810	30.0
1913	do	3,341,517	25,927	6,021.70	.775	23.2
1914	10 per cent	3,373,266	29,300	2,930.00	.869	10.0
1915	do	1,914,114	16,507	1,650.70	.864	10.0
1916	do	1,345,418	10,811	1,081.10	.799	10.0
1917	do	448,767	5,967	596.70	1.33	10.0
1918	do	312,996	3,653	365.00	1.17	10.0
1919	do	179,700	3,509	351.00	1.95	10.0

Brown, Spanish, Indian red, and colcothar or oxide of iron—Imports for consumption—Revenue.

Calendar year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1911	30 per cent		$94,045	$28,213.50		30.0
1912	do		102,626	30,787.80		30.0
1913	do		127,103	27,454.70		21.6
1914	10 per cent		214,343	21,426.80		9.0
1915	do		168,346	16,834.60		10.0
1916	do		230,281	23,028.10		10.0
1917	do		343,124	34,312.40		10.0
1918	do		311,425	31,143.00		10.0
1919	do	9,971,744	307,413	30,741.00	$3.08	10.0
1920 [1]	do	6,136,134	205,290	20,529.00	3.36	10.0

[1] Six months.

Venetian red (iron oxide pigments, par. 55, act of 1913), prices per pound, New York, wholesale spot.

[From Oil, Paint, and Drug Reporter.]

	Dry.	In oil.		Dry.	In oil.
	Cents.	*Cents.*		*Cents.*	*Cents.*
January, 1912	1–1½	6– 8	April, 1916	2 –2¾	10–12
April, 1912	1–1½	6– 8	July, 1916	2 –2¾	10–12
July, 1912	1–1½	6– 8	October, 1916	2 –2¾	10–12
October, 1912	1–1½	6– 8	January, 1917	2 –2¾	10–12
January, 1913	1–1½	6– 8	April, 1917	2¾–4	10–12
April, 1913	1–1½	6– 8	July, 1917	2¾–4	10–12
July, 1913	1–1½	6– 8	October, 1917	2¾–4	10–12
October, 1913	1–1½	6– 8	January, 1918	2¾–4	15–18
January, 1914	1–1½	6– 8	April, 1918	2¾–4	15–18
April, 1914	1–1½	6– 8	July, 1918	2¾–6	15–18
July, 1914	1–1½	6– 8	October, 1918	2¾–6	15–18
October, 1914	1–1½	6– 8	January, 1919	2¾–6	15–18
January, 1915	1–1½	6– 8	April, 1919	2¾–6	15–18
April, 1915	1–1½	6– 8	July, 1919	2 –4½	16–18
July, 1915	1–2	8–10	October, 1919	2 –4½	16–18
October, 1915	1–2	8–10	January, 1920	2½	16–18
January, 1916	1–2	8–10	April, 1920	2½–5	16–18

Red iron oxide pigments, par. 55, act of 1913—Prices per pound.

	Indian red.		Oxide red.		Crocus martus.	
	English.	Standard American.	English.	American.	Imported.	Standard American.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January, 1912	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
April, 1912	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
July, 1912	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
October, 1912	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
January, 1913	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
April, 1913	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
July, 1913	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
October, 1913	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
January, 1914	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
April, 1914	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
July, 1914	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
October, 1914	5–7	1½– 1¾	2¼–10	2 – 7	1½–3½	1–2½
January, 1915	.....	1½– 5 [1]	.....	2 –10 [2]	1½–3½ [3]	.....
April, 1915	.....	1½– 5 [1]	.....	2 –10 [2]	1½–3½ [3]	.....
July, 1915	.....	1½– 5 [1]	.....	2½– 9	1½–3½ [3]	.....
October, 1915	.....	2½– 5	.....	2½– 9	1½–3½ [3]	.....
January, 1916	.....	2½– 5	.....	2½– 9	1½–3½	.....
April, 1916	.....	5 – 6	.....	3 – 8½	3 –4½	.....
July, 1916	.....	5 – 6	.....	2 – 8½	3 –5	.....
October, 1916	.....	5 – 6	.....	3 – 8½	3 –5	.....
January, 1917	.....	7 – 9½	.....	3 – 8½	3 –5	.....
April, 1917	.....	7 –10	.....	3½–12	3 –5	.....
July, 1917	.....	7 –10	.....	4¼–15	3 –5	.....
October, 1917	.....	10 –14	.....	4¼–15	3 –5	.....

	Indian red.		Copperas, powdered.		Oxide red.	Crocus martus.
	English.	Standard American.	English.	American.	Spanish.	Standard American.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January, 1918	15–17	12–15	13–16	3¾–4½	[4]	4
April, 1918	18–24	12–15	13–16	3¾–4½	4½–5	4
July, 1918	18–24	8–12	15–20	3¾–4½	7 –8	4
October, 1918	18–24	8–12	15–20	3¾–4½	7 –8	4
January, 1919	20–24	8–12	15–20	3¾–4½	5½–6	4
April, 1919	14–16	14–16	12–16	3¾–4½	4½–5	4–4½
July, 1919	14–16	14–16	12–16	3¾–4½	4½–5	4–4½
October, 1919	14–16	14–16	12–16	2 –3½	3½–4	4–4½
January, 1920	14–16	14–16	12–16	2 –3½	4½	4–4½
April, 1920	14–16	14–16	14–18	2 –3½	4½–5	4–4½
July, 1920	14–16	14–16	15–18	4½–7	5 –6½	4–4½
October, 1920	14–18	12–16	15–18	4½–9	5 –6½	4–4½

[1] Listed as Indian red, standard, until 1918.
[2] Listed as oxide red until 1918.
[3] Listed from here as "crocus martus."
[4] Not quoted.

Spanish brown, Indian red, dry or moist, colcothar, dry oxide of iron—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	87	Colors and paints, * * * whether dry or mixed, or ground with water or oil, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	61	All other paints and colors, whether dry or mixed, or ground in water or oil, * * * not specially provided for in this act.	Do.
1894	48	All other paints, colors, and pigments, whether dry or mixed, or ground in water or oil, or other solutions, * * * not specially provided for in this act.	Do.
1897	58	All paints, colors, pigments, * * * whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this act.	30 per cent ad valorem.
1909	56	All paints, colors, pigments, * * * whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this section.	Do.
1913	55	* * * Spanish brown, venetian red, Indian red, and colcothar or oxide of iron, not specially provided for in this section.	10 per cent ad valorem.

Court and Treasury Decisions.

Oxides of iron in general use both as colors and as polishing powders were held dutiable under the provision in paragraph 479 of the act of 1883 for "polishing powders of every description, by whatever name known," and not under the provision in paragraph 87 for colors and paints. (Zucker, etc., Chemical Co. *v.* Magone, 37 Fed., 776.)

Venetian red was classified as a dry paint and not as ochery earth under the act of 1890 (G. A. 629, T. D. 11346), but red earth, a calcareous earth colored by ferric oxides of a red color and similar in appearance to red hematites, was classified as ochery earth (G. A. 1880, T. D. 13608).

Oxide of iron used to purify coal gas by abstracting the sulphur therefrom was classified as an unenumerated unmanufactured article under that act. (G. A. 4146, T. D. 19355.) Oxide of iron in the form of loose earth and declared to be in fact an Indian red in a crude condition was held to come within paragraph 58 of the act of 1897 as a crude pigment. (G. A. 4201, T. D. 19580.)

A red pigment imported to be used as a color was held dutiable as a color rather than as an ochery earth or as an ocher. (Vandegrift *v.* United States, 107 Fed., 265.)

Crocus, a product from the dross or residuum of burnt pyrites treated by a process to eliminate the sulphur and used properly as a polishing powder, but to a considerable extent as a painter's color, was held dutiable as a color and not as dross or residuum from burnt pyrites under the act of 1890. (Smith *v.* United States, 93 Fed., 194.) This case was followed in the classification of oxide of iron in the form of a ground hematite which was classified as a color and not as unwrought and unmanufactured earth under paragraph 93 of the act of 1897. (G. A. 5016, T. D. 23346.)

Oxide of iron in its condition as taken from the ground without any preparation whatever, intended for use as a pigment, was classified under paragraph 55 of the act of 1913 at the 10 per cent rate. (T. D. 34390.)

Tuscan red No. 4076 DX, claimed to be oxide of iron within paragraph 55, or pigment within paragraph 61 of the 1913 act, was returned by the chemist as containing about 10 per cent of coal-tar

coloring matter, some inert diluent, and the remainder iron oxide with a little moisture inherent in colors. The definition in the Oxford dictionary of the word "lake" was followed, and the merchandise held dutiable accordingly under paragraph 63 of the act of 1913. (Abstract 40363.)

Tuscan red, a coal-tar color lake composed of oxide of iron and containing about 4 per cent of aniline color, was held dutiable under Group III of section 500 of the revenue act of September 8, 1916, at 30 per cent ad valorem, plus the special duty of 5 cents per pound imposed in section 501. (Abstracts 42413, 42464, and 43708.) An appeal is pending in the Court of Customs Appeals from Abstract 43708 upon the question whether the special duty of 5 cents per pound accrued. (T. D. 38444.)

(See also survey on Paints of all kinds, par. 63, infra.)

LEAD PIGMENTS.

OXIDES OF LEAD—LITHARGE, RED LEAD, AND ORANGE MINERAL.

[Par. 56, 25% ad val.]

SUMMARY.

The oxides of lead are less important pigments at the present time than they have been in the past, but they are used more largely in other industries. *Litharge*, the monoxide, which was formerly used as a coloring agent in yellow paint, is now used in the paint industry for the preparation of boiled linseed oil and to some extent in preservative paints. The chief consumption is in glass making and pottery manufacture. Litharge is the chief source of lead for the production of lead acetate and other lead salts and for many lead pigments, especially the chromates. There are numerous minor uses. *Massicot* is another variety of lead monoxide, differing only in physical properties from litharge. It is made almost exclusively for the manufacture of red lead. *Red lead*, lead tetroxide, is a very heavy orange-red pigment having great covering power and brilliancy. It has been largely used in preservative paints for structural steel. Like litharge it is also used in making glass. *Orange mineral* is a variety of red lead which has been prepared with special care. It is generally made from white lead whereas red lead is made from massicot which is prepared by the oxidation of molten metal. It is more expensive than red lead and is often stained with organic dyes and sold as artificial vermilion or "vermilionette." Both orange mineral and red lead are used in making rubber goods.

The United States is a large producer and consumer of lead oxides. The output in 1916 was 121,548,000 pounds, valued at nearly $10,000,000. Over 62 per cent of the quantity and 60 per cent of the value was in the form of litharge; the remainder consisted almost wholly of red lead, as orange mineral is used in only minor amounts in this country. The chief localities of production are Pennsylvania, New York, Missouri, Illinois, Ohio, and California. For more than 20 years the litharge supply has come almost wholly from domestic sources. The prewar consumption (1910–14) was about 25,000 tons annually. There is a small production as a by-product of lead refining, but most of the output is made from pig lead. The consump-

tion of red lead during the five years ended December 31, 1914, was about 19,000 tons annually. Less than 5 per cent of this was imported. Nearly one-half of the 1,000 to 2,000 tons of orange mineral used annually in this period was imported.

About 90 per cent of the weight and a large fraction of the value of litharge and red lead consists of metallic lead. Since the cost of metallic lead is generally greater in the United States than in European countries, the domestic producer of lead oxides is at a considerable disadvantage as regards the cost of his raw material. Fuel requirements are an important item, but the slightly cheaper fuel cost in this country does not offset the higher cost of lead. Labor is also a larger factor than it is in the manufacture of most paint products.

Oxides of lead (litharge, red lead, and orange mineral)—Summary table.

Calendar year.	Domestic production.[1]	Imports for consumption.[2]	Domestic exports.	Ratio of imports to production.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
	Pounds.	*Pounds.*	*Pounds.*	*Per ct.*				
1910	88,280,000	1,471,443	([3])	1.67	$67,201	[4]$42,317.40	$0.0456	62.9
1911	91,100,000	1,692,929	([3])	1.86	75,881	41,998.17	.0448	55.3
1912	101,552,000	1,124,802	([3])	1.11	56,318	31,579.08	.0501	56.2
1913	82,324,000	463,930	([3])	.56	28,858	11,117.34	.0623	38.5
1914	92,936,000	296,593	([3])	.31	21,100	4,613.25	.0738	[5]21.9
1915	91,106,000	194,190	([3])	.21	15,615	3,903.75	.0806	25.0
1916	121,548,000	92,721	([3])	.08	14,233	3,558.25	.1536	25.0
1917	.....	33,344	([3])	.....	4,905	1,225.25	.1473	25.0
1918	.....	.....	5,739,819	.....	.....	.....	.....	.....

[1] U. S. Geol. Survey Data.
[2] All classes combined.
[3] Included under "All Other Paints" prior to July 1, 1917.
[4] Calculated.
[5] Red lead valued at $3,681 imported free of duty for construction of vessels.

General Information.

PARAGRAPH 56, TARIFF ACT OF 1913.

"Lead pigments: Litharge, orange mineral, red lead, white lead, and all pigments containing lead, dry or in pulp, and ground or mixed with oil or water, not specially provided for in this section, 25 per cent ad valorem."

This survey deals only with the so-called "lead oxides" which comprise litharge, red lead, and orange mineral. White lead is discussed separately in this series. All other pigments containing lead and which are important commercially are provided for in other paragraphs of the tariff act.[1]

DESCRIPTION.

There are several oxides of lead. Most of these, however, are of purely theoretical interest and the only ones that are important in the paint industry are litharge, the monoxide, and red lead and its modification, orange mineral, the tetroxide.[2]

[1] Lead chromates, Par. 54. Vermilion red, containing lead but not containing quicksilver, Par. 59. Vermilionettes (red lead stained with eosine) are classified as "lakes."
[2] Lead dioxide (PbO_2) is used to some extent in the manufacture of aniline.

Litharge (PbO) is a reddish yellow powder.[1] It is not so important as a pigment as it is for the preparation of "boiled linseed oil." It is used to some extent in the manufacture of preservative paints because it is basic (not acid) and resists corrosion. Litharge and linseed oil make a very hard cement-like film that withstands abrasion, but the litharge combines with the oil so fast that when used in mixed paints it tends to "liver"[2] and saponify. A few black paints are held together by the use of litharge and, provided they are used within a month or two after they are made, serve their purpose perfectly.[3] One of the largest uses of litharge is in the making of lead or "flint" glass and in a large number of pottery glazes. It is also used as a flux in the assaying of gold and silver ores and, because of its ready solubility in acids, as a source of lead in the manufacture of many salts and compounds of lead (especially the acetate and nitrate). Litharge is frequently used as a pipe-joint cement, although not so satisfactory as red lead for this purpose. At one time litharge was used as a yellow pigment, but at the present time its chief function in the paint industry is as a drier. The rubber industry is another large consumer of litharge.

Massicot is another variety of lead monoxide, differing from litharge only in physical properties. It has a lighter yellow shade than the latter and is prepared chiefly for the manufacture of red lead.

Red lead is lead tetroxide (Pb_3O_4). Chemically it is regarded as a mixture of lead monoxide and peroxide ($2PbO.PbO_2$), but commercial samples vary somewhat from this formula. It is a very heavy orange-red pigment, a little variable in color but having great covering power and brilliancy. Red lead was the first successful protective coat for structural iron and steel and is still preferred by some engineers. It is, however, a difficult pigment to use properly, since it must be applied very soon after mixing to avoid undue combination with the oil,[4] and if it is not mixed with an inert base is very fatiguing to the painter that does the work. The high specific gravity of red lead makes it very heavy on the brush, and the workman is very likely to thin his paint so as to make it flow easier and thereby loses the protective quality of the coat. For this reason red lead is being mixed more and more with other pigments, especially graphite and iron oxides (and metallic paints), and has even been replaced in many instances by the latter. Asphaltum and other bituminous bases are also substituted frequently in outside work.

Because of its active oxidizing effect with linseed oil, red lead is very extensively used as a lute in plumbing and gas fitting. A large use of red lead is for glass making. A minor consumption is in the manufacture of storage batteries.

Orange mineral has the same chemical composition as red lead but differs in color and in its (lower) specific gravity. Strictly it is merely a very pure form of red lead, but it is manufactured from white lead,[5] whereas red lead is produced from lead metal. Orange

[1] Very pure litharge has the color of yellow ochre. The shade of commercial litharge varies, however, from lemon yellow to reddish yellow and on heating it becomes brownish red.
[2] Stiffen the oil so that the paint can not be applied with a brush.
[3] Toch. Chemistry and Technology of Paints. Van Nostrand. 1916.
[4] One proprietary brand (Dutch Boy Red Lead) will remain soft in oil, though nearly pure.
[5] Generally the scum that collects on the surface of the wash waters used in levigating white lead. White lead was also used as a source of massicot when that pigment was important as a paint material (i. e. prior to the improvements in chrome yellows).

mineral is the variety of red lead which is stained with eosine and sold as artificial vermilion or "vermilionette." It is valued by the depth of its orange shade.

DOMESTIC PRODUCTION.

The domestic output of lead oxides increased nearly 50 per cent from 1900 to 1910, and before the outbreak of the war increased another 50 per cent. The production of all classes of lead oxides in the United States in 1914 was practically 93,000,000 pounds, valued at something over $5,000,000.[1] The increased use of structural steel through the war period (especially for ships and shipyards) and the heavy demands from the glass and rubber industries called for larger quantities of these oxides than had ever before been produced. The output in 1916 was 121,548,000 pounds, valued at nearly $10,000,000. Over 62 per cent of the quantity and 60 per cent of the value of the 1916 output of these oxides was in the form of litharge; the remainder was almost wholly red lead, orange mineral not being made in important quantities in this country.

Raw materials.—The fundamental raw material of all the lead oxides is, of course, metallic lead, which constitutes more than 90 per cent of the weight of these products and a considerable fraction of the value. A fraction of the litharge supply is derived as a by-product of the desilverization of lead bullion, but it is made chiefly from market lead. Red lead is also made from the metal and to only a slight extent from unmarketable qualities of white lead. There is also a process for the production of red lead from litharge (instead of massicot) using nitrate of soda (converted to nitrite of soda).[2]

Processes of manufacture.—Litharge and massicot are both made chiefly by the oxidation of melted lead in the air. The essential difference is that litharge is produced at a temperature sufficiently high to melt the lead monoxide (about 900° C.), whereas massicot is produced when the temperature is considerably below the melting point of the oxide.

Litharge is frequently made in rotating drums made of cast iron and heated by an external fire. The drums have shelves or ribs inside which pick up the melted lead and cause it to fall in thin films through a current of air which is drawn through by a fan.[3] It is also produced in furnaces of the reverberatory type, but equipped with suitable arrangements for blowing air over the surface of the molten lead which, in effect, much resembles the cupelling operation in refining lead bullion and which furnishes part of the domestic litharge supply. The melted litharge from the furnace can be run over an iron plate and chilled with water. This produces yellow litharge in more or less lump form. Slow cooling favors the formation of a red, flaky variety. This is formed by allowing the melted litharge to collect in front of the furnace in cakes of from 1 to 1.5 tons in weight where it will cool very slowly.[4] The inner part of the cake will swell up and form flakes of red litharge; the outer and

[1] Compilations of Mineral Industry and of Geological Survey. Census data show only about two-thirds this amount.
[2] See Holly's "Analysis of Paint and Varnish," p. 221.
[3] Thorp. Outlines of Industrial Chemistry. MacMillan. 1916.
[4] Hofman, H. O. Metallurgy of Lead. McGraw-Hill. 1918.

lower part, which necessarily is chilled more rapidly, solidifies in lumps of yellow oxide. The flake is separated from the lump by sifting and is marketed as flake. The solid material that remains on the screens is ground wet, settled in water, and dried. It is sold as levigated or buff litharge.

Red lead is made in two operations. The first is the production of massicot. This is merely a drossing operation in which a bath of metal is kept at a temperature not much greater than its melting point (in a reverberatory furnace or kettle) and poled and raked so as to expose fresh surfaces to the air. The oxide that collects on the surface is skimmed off periodically. The massicot then goes to another furnace (usually after a levigating process), where it undergoes a coloring process. This consists simply in heating to a dull red heat in a muffle or reverberatory furnace with free access of air. The mass is stirred from time to time in order to assist the absorption of oxygen and to develop the color. Samples are taken at intervals until the desired shade is obtained. This takes from 40 to 48 hours; then the furnace is allowed to cool. The product is usually ground before packing for market.[1]

The above operations indicate a considerable amount of labor and an enormous amount of fuel required in the processes of manufacture. The latter is only partly offset by the considerable production in and around metallurgical plants where there is frequently more or less waste heat. Careful temperature control is essential; so a certain amount of skilled labor and technical supervision is necessary.

Localities of production.—Pennsylvania is the largest producing State but New York is a close second in the production of all classes of lead oxides. Missouri and Illinois follow next in order, each being practically equally important.

The census data show that in 1909 Pennsylvania and New York produced nearly two-thirds of the total output of the United States. Missouri and Illinois together furnished about 11 per cent, Ohio supplied nearly 7 per cent, California a little more than 1 per cent, and the remaining 15 per cent came from various other States. The figures for 1914 are less detailed, but show that 30 per cent came from Pennsylvania and Missouri furnished about 5½ per cent of the total. Out of 24 establishments that produced lead oxides in that year, 2 consumed the whole of their product, 5 of the remainder were located in Pennsylvania, 3 were in Missouri, and the rest in States not specified.

The reports of the Geological Survey are not much more informative. The statement is made, however, that litharge was produced in 1912 in New York, Missouri, Pennsylvania, Massachusetts, New Jersey, Michigan, Ohio, and California, the States being named in order of their importance. Red lead is reported as having been made in 1913 at 4 plants in Pennsylvania, 2 plants each in New York and Missouri, and at 1 plant each in California, Michigan, New Jersey, and Ohio.

The data from the two sources vary, as do the statistics of production, but they both indicate that most of the oxides of lead are manufactured in the Middle Atlantic States or close to the lead smelting districts of the Mississippi Valley, the former being close to the centers of consumption or at least distribution of the product and the latter being situated close to sources of supply of the raw material. The advantage

[1] Thorp. Loc cit.

as regards fuel is slightly in favor of the latter, but this is largely offset by the better labor supply and lower freights of the eastern plants.

Domestic production and consumption.—The prewar (1910–1914) consumption of litharge in the United States was about 25,000 tons annually as compared with an average of slightly less than 13,000 tons in 1900 to 1909. The corresponding figures for red lead are 19,000 and 14,000 tons, respectively. For more than 20 years the litharge supply had come almost wholly from domestic sources. A slightly larger fraction of the red lead requirements were imported, but even in the first decade the imports rarely amounted to as much as 5 per cent of the total consumption and in the latter part of the war period the United States was producing an excess supply (of about 5 per cent), which was exported.

The tonnage requirements of orange mineral, however, rarely have exceeded 1,000 or 2,000 tons per year. A much larger fraction of this tonnage is imported than in the case of the more largely used oxides. The quantity imported has averaged very nearly the same as the quantity of red lead and during the five years immediately preceding the war was roughly equal to the domestic production. The statistics, however, are incomplete as some orange mineral produced in domestic establishments is reported as red lead. Even before the outbreak of the war the imports of orange mineral were declining rapidly and during the war period became practically negligible.

Domestic exports.—The only data as regards exports of lead oxides are those showing the exports of red lead since July 1, 1917. Nearly 3,000 tons of red lead were exported during the calendar year 1918. This represents practically the whole outward movement of lead oxides. The largest single exportation was to Brazil and fully one-half of the total went to South American countries. The next largest shipments were to the Dutch East Indies and other large amounts were consigned to various destinations in the Far East, including the Philippines, India, Australia, and China. Canadian deliveries were less than 15 per cent of the total. Canada, however, is a large consumer of American litharge and imported approximately 1,250 tons, valued at $206,513, in 1917.

FOREIGN PRODUCTION.

The production of these oxides in foreign countries has not been investigated in the preparation of this unit. For many years red lead was produced almost exclusively in England, but in later years Germany and doubtless other countries commenced its manufacture on a large scale, much as was done in the United States. In 1913, however, 3,400 short tons of red lead are reported [1] as imported into the United Kingdom. This came chiefly from Germany; small amounts were imported from Netherlands, France, and other countries. During the war the imports of red lead into the United Kingdom dropped off to only a few hundred tons annually and in 1915 and thereafter most of this came from the United States, which had not hitherto figured in the imports. The maximum quantity received from the United States was in 1916, when this country was credited with 8,670 hundredweight (971,040 pounds), valued at more than $90,000 (c. i. f.).

[1] Trade of the United Kingdom. It is probable that these data include both red lead and orange mineral.

IMPORTS.

All three classes of lead oxides are listed separately in the publications of the Department of Commerce. The imports for consumption show wide fluctuations from year to year, but as has been mentioned above very little litharge is imported, whereas red lead and orange mineral are imported in much larger quantities. The course of the imports can perhaps be best brought out by the following table:

Article.	Average annual imports.		Maximum annual imports.[2]
	Period 1910–1914.	Period 1900–1909.	
	Pounds.	*Pounds.*	*Pounds.*
Litharge	42,725	76,611	[3] 120,101
Red lead	635,980	812,760	[4] 1,219,503
Orange mineral	441,666	801,699	[4] 1,077,028

[2] Since 1900.
[3] 1905.
[4] 1903.

During the war period the imports fell off very rapidly and in 1918 (fiscal year) the imports were absolutely negligible, the largest being orange mineral to the value of $1,407, whereas the 5 pounds of red lead listed were valued at $1 and the 100 pounds of litharge were declared at a total value of $12.

On account of the comparatively small quantities of lead oxides imported into the United States in recent years these imports have furnished little revenue. The maximum under the act of 1913 was during the nine months immediately preceding the outbreak of the war, when the duties collected on all classes of these oxides amounted to only $5,969.50, or less than $9,000 when calculated on a yearly basis. Over 80 per cent of this amount was collected on imports of orange mineral.

PRICES.

Lead oxides follow the course of the pig lead market a little more closely than does white lead, as much less time elapses between the purchase of the metal and its conversion into salable material. There are no fixed differentials between the cost of these oxides and pig lead, but a study of the price statistics reveals that litharge can generally be assumed to have a differential of approximately 1¼ cents above pig lead or from one-fourth to one-half cent above white lead. Red lead runs at about one-half cent per pound higher than litharge. The range in prices of orange mineral is greater because of wider differences in qualities, but will average between 2 and 3 cents higher than red lead or as much as 5 cents above the price of pig lead.

The above differentials can in no sense be considered fixed and are frequently departed from considerably, especially during periods of market fluctuation. This was most marked in 1918. In the early part of the year the price of lead was comparatively low, whereas oxides were at levels corresponding to the price of lead previous to

the decline that took place in the latter part of 1917 and which, in the opinion of oxides producers, was not justified by conditions. But later, when the price of lead advanced to more than 1.8 cents higher than the opening price of the year, the average advance of pigments was only abour 1 cent.

TARIFF HISTORY.

The tariff history of lead oxides is closely linked with that of white lead and of pig lead. In 1890, however, litharge, orange mineral, and red lead were all dutiable at 3 cents per pound as compared with a duty of 2 cents per pound on the metal. The only change of the act of 1890 was to increase the duty on orange mineral to 3½ cents, recognizing it as a more expensive product than either of the other two. Like all lead articles, the oxides were subject to much lower duties under the act of 1894. The reduction as compared with the rates of the act of 1890 was 50 per cent.

In 1897, however, the rates reverted almost to the duties of 1890, but in this act the duty on litharge as compared with the other oxides was reduced, following evidently the same policy that had prompted the increase in duty on orange mineral. The new rates checked the extraordinary importations that had developed during the period of low duties.[1]

The act of 1909 made further slight reductions in the duties on lead oxides. The reduction on litharge and on red lead was one-fourth cent per pound while that on orange mineral was only one-eighth cent per pound, adding thereby to its relative protection as compared to the other lead articles. The duties under the act of 1909 together with the corresponding ad valorem rates were as follows:

Article.	Duty.	Equivalent ad valorem rate.[1]
	Cents per pound.	*Per cent.*
Litharge	2¼	51.5–55.1
Red lead	2⅜	52.8–66.3
Orange mineral	3¼	[2] 50.3–59.7

[1] Highest and lowest average for any fiscal year. In general the higher figure refers to the first few years while the lower refers to later years, when the prices of pig lead and all its derivatives were rising rapidly.
[2] Average for the last three months in which this act was in force (July 1 to Oct. 3, 1913) was only 48 per cent.

In 1913 ad valorem duties were adopted generally for all commodities in which the article of chief value was lead and, like other lead articles, the duty on lead oxides (as well as that on white lead, which was included with these commodities in the same paragraph) was placed at 25 per cent ad valorem. Referring to the above table, it will be noted that the new duties were considerably less than under the act of 1909. Nevertheless, the quantities imported did not in-

[1] The imports of litharge more than doubled under the act of 1894, while those of red lead increased to more than three times their former amount. Orange mineral imports, being less strictly competitive with the domestic product, did not increase so largely, but advanced over 80 per cent. It is interesting to note that in spite of the slightly lower duties under the act of 1897, as compared with those of 1890, the imports were much less, indicating perhaps a strengthening of the domestic industry under the active competition that accompanied the low duties.

crease. Due to conditions in no way related to the tariff, they continued to decrease.

COMPETITIVE CONDITIONS.

The competitive conditions with respect to the lead oxides are essentially those that concern the chief raw material, pig lead, and are altered in only slight measure by the consideration of fuel, which is generally cheaper in the United States than in other producing countries. In the case of orange mineral the situation is complicated somewhat by the fact that white lead is an intermediate product in the manufacture and that, being a higher priced commodity, it is marketed on a basis more especially of quality than of price. The position of the domestic manufacturer of oxides is therefore quite similar to the position of producers of other articles that consist largely of lead. As this situation has been discussed in considerable detail under survey on "White lead" and also in the survey on Lead Metal (Par. 153) it does not seem necessary to enter into any lengthy discussion of the subject here.

TARIFF CONSIDERATIONS.

The oxides of lead introduce little of interest from a tariff standpoint except as products made from lead. This subject has been discussed at considerable length elsewhere. The few protests that appear in tariff hearings strike at the fundamental principle of protecting the metal and its products. There is also an occasional reference to the difficulty of distinguishing between orange mineral and the cheaper red lead when the specific duties were in force. While the adoption of ad valorem duties seems to have adjusted this difficulty the following statement may be interesting:

> There is no reason for the existence of separate duties on these items—orange mineral is only a high grade of red lead. The existence of distinct duties renders it easy for the entering of the superior red lead (orange mineral) at the lower rate of duty—the red-lead duty. One tariff on these items would render this impossible.

During the periods of specific duties, the tariff policy would seem to have been to roughly apportion the duties on the lead oxides according to the differences in price both with reference to one another and with reference to pig lead. In the act of 1913, this policy was carried out in the form of ad valorem rates.

Lead oxides (red lead, orange mineral, and litharge)—Production in United States.

OFFICIAL SOURCE.

[From "Federal Census."]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1899	[1] 64,466,000 [2] 62,386,000	$2,862,743	1909	[1] 70,293,679 [2] 65,767,254	$3,798,551
1904	[1] 73,326,000 [2] 63,476,000	3,509,275	1914	[1] 61,335,290 [2] 58,642,588	3,281,716

OTHER SOURCES.

[From Mineral Industry.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1900	42,770,000	$2,217,966	1912	101,552,000	$5,854,141
1904	55,100,000	3,089,941	1913	82,324,000	4,724,308
1909	59,442,000	2,773,103	1914	92,936,000	5,077,165
1910	60,632,000	2,836,942	1915	91,106,000	5,227,315
1911	91,100,000	5,198,086	1916	121,548,000	9,787,109

[1] Total production.
[2] Marketed production. Does not include products consumed at plant where made.

Red lead—Production in United States.

OFFICIAL SOURCE.

Figures for 1899, 1904, 1909, and 1914 are included under "Lead Oxides."

OTHER SOURCES.[1]

[From Mineral Resources, part 2.]

Year.	Quantity.[2]	Value.	Year.	Quantity.[2]	Value.
	Short tons.			*Short tons.*	
1909	19,103	$2,335,799	1913	17,635	$2,127,976
1910	19,833	2,453,014	1914	18,697	2,151,054
1911	19,540	2,345,320	1915	19,435	2,397,900
1912	21,120	2,571,702	1916	23,035	3,933,566

[1] Marketed production of chemically manufactured pigments.
[2] Contains a small quantity of orange mineral.

Litharge—Production in United States.

OFFICIAL SOURCE.

[From "Federal Census."]

Figures for 1899, 1904, 1909, and 1914 are included under "Lead Oxides."

OTHER SOURCES.

[From Mineral Resources, part 2.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1909	20,690	$2,363,002	1913	23,093	$2,524,707
1910	23,766	2,689,016	1914	27,345	2,856,092
1911	25,190	2,773,196	1915	26,118	2,822,415
1912	29,111	3,194,194	1916	37,739	5,853,543

Orange mineral—Production in United States.

Figures for 1899, 1904, 1909, and 1914 are included under "Lead Oxides."

[From Mineral Resources, part 2.][1]

Year.	Quantity.[2]	Value.	Year.	Quantity.[2]	Value.
	Short tons.			*Short tons.*	
1909	590	$98,723	1913	434	$71,625
1910	823	136,082	1914	426	70,019
1911	766	119,370	1915	[3]	
1912	545	88,245	1916	[3]	

[1] Marketed production of chemically manufactured pigments.
[2] A small quantity of orange mineral is included with red lead.
[3] Total production included with red lead.

Lead—Litharge—Imports for consumption—Revenue.

[Changed Oct. 4, 1913, to: Lead pigments, dry or in pulp, or ground, or mixed with oil or water, n. s. p. f.

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	2½ cents per pound.	48,693	$2,252		$0.0463	
1911	....do....	24,662	1,196	$616.56	.0486	51.3
1912	....do....	32,443	1,550	811.08	.0478	52.3
1913		34,023	1,750	647.24	.0515	37.0
1914	25 per cent	33,651	1,805	451.25	.0535	25.0
1915	....do....	20,650	1,422	355.50	.0689	25.0
1916	....do....	1,320	150	37.50	.114	25.0
1917	....do....					
1918	....do....	100	12	3.00	.120	25.0
1919	....do....					
1920[1]	....do....					

[1] Six months ending June 30, 1920.

Lead—Orange mineral—Imports for consumption—Revenue.

[Changed Oct. 4, 1913, to: Lead pigments, dry or in pulp, or ground, or mixed with oil or water, n. s. p. f.—Orange mineral.]

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	3¼ cents per pound.	600,461	$32,199		$0.0536	
1911	....do....	504,734	28,515	$16,403.85	.0545	57.5
1912	....do....	334,551	20,914	10,872.91	.0623	52.1
1913		330,525	22,205	9,006.85	.0673	40.5
1914	25 per cent	240,388	16,388	4,097.00	.0673	25.0
1915	....do....	171,572	14,061	3,515.25	.082	25.0
1916	....do....	70,934	8,781	2,195.25	.124	25.0
1917	....do....	33,294	4,892	1,223.00	.147	25.0
1918	....do....					
1919	....do....	39,781	5,082	1,270.50	.128	25.0
1920[1]	....do....					

[1] Six months ending June 30, 1920.

Lead—Red—Imports for consumption—Revenue.

[Changed Oct. 4, 1913, to: Lead pigments, dry or in pulp, or ground, or mixed with oil or water, n. s. p. f.—Red.]

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	2¼ cents per pound.	822,289	$32,750		$0.0399	
1911	do.	1,163,533	46,170	$24,977.76	.0399	54.0
1912	do.	757,908	33,854	19,895.09	.0447	58.7
1913		99,832	4,903	1,463.25	.0490	29.8
1914	25 per cent	12,554	2,907	65.00	.233	22.4
1915	do.	1,968	132	33.00	.067	25.0
1916	do.	20,467	5,302	1,325.50	.259	25.0
1917	do.	50	13	3.25	.260	25.0
1918	do.	5	1	.25	.200	25.0
1919	do.	7,199	1,135	283.75	.157	25.0
1920[1]	do.					

[1] Six months ending July 30, 1920.

Red lead—Domestic exports.[1]

Exported to—	1918 (fiscal year).		1918 (calendar year).		1919 (calendar year).	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Norway	85,393	$9,667	313,878	$33,772	10,740	$1,229
Canada	552,823	60,055	713,044	75,717	838,740	78,914
Panama	239,873	30,042	62,433	6,262	58,903	6,093
Mexico	66,035	8,349	72,458	9,167	140,294	17,201
Cuba	163,800	19,859	145,078	17,364	69,250	9,452
Argentina	298,147	38,838	311,616	38,007	909,467	107,844
Brazil	887,699	106,380	1,049,898	123,259	937,844	114,647
Chile	369,871	45,390	180,476	20,949	106,660	12,410
Uruguay	72,721	9,462	44,093	6,037	127,604	16,820
China	72,861	8,691	113,639	13,498	176,688	21,785
British India	296,547	30,996	244,763	24,722	3,784	427
Dutch East Indies	647,064	76,513	890,527	103,537	406,712	47,722
Australia	162,122	19,452	207,276	24,072	562,331	66,421
Philippine Islands	333,021	39,167	341,752	38,729	772,690	92,472
All other	544,353	64,993				
Total	4,792,330	567,854	5,739,819	662,584	6,227,797	735,177

1 Included in "Paints, etc., all other," prior to 1918.

Orange mineral and red lead—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Orange mineral and red lead	3 cents per pound.
1883	.....	Litharge	Do.
1890	65	Orange mineral	3½ cents per pound.
1890	66	Red lead	3 cents per pound.
1890	63	Litharge	Do.
1894	51	Orange mineral	1¾ cents per pound.
1894	51	Red lead	1½ cents per pound.
1894	49	Litharge	Do.
1897	50	Orange mineral	3⅜ cents per pound.
1897	51	Red lead	2¼ cents per pound.
1897	60	Litharge	2½ cents per pound.
1909	48	Orange mineral	3¼ cents per pound.
1909	49	Red lead	2⅛ cents per pound.
1909	58	Litharge	2½ cents per pound.
1913	56	Lead pigments: Litharge, orange mineral, red lead, white lead, and all pigments containing lead, dry or in pulp, and ground or mixed with oil or water, not specially provided for in this section.	25 per cent ad valorem.

WHITE LEAD.

(Par. 56, Act of 1913, 25 per cent ad valorem.)

SUMMARY.

Basic carbonate white lead is an artificial white pigment consisting of a mixture of carbonate and hydroxide of lead. *Sublimed white lead* is a basic sulphate of lead and is an entirely different article. The former is almost invariably made from metallic lead by a chemical process; the latter is made direct from lead ore by furnace treatment. One or the other of these pigments is a constituent of nearly all mixed paints. Straight white lead—basic carbonate lead in oil with no other pigment—was formerly considered the only pure white paint. But in recent years it has been proved that a mixture of pigments results in a more durable and generally satisfactory paint. Zinc white and barium sulphate, which were at one time thought to be adulterants, are now added for their beneficial effect. In spite of these substitutes, however, the growth in the consumption of white lead has kept pace with the growth in population in the United States during the 10 or 15 years prior to the outbreak of the war. The chief consumption is for exterior painting, and the enormous quantities now used are in large measure an index of the greater attention given to the better appearance and protection afforded by painting dwelling houses and outbuildings.

The domestic production of white lead in 1914 was 279,417,563 pounds, valued at $14,410,324 (census data), and was produced in 20 establishments. The larger part of the output comes from plants located in or near New York City.

Most of the white lead is made by the so-called Dutch process, which involves a considerable plant area. It is very slow and there is generally a lapse of six months between the time the lead metal is bought and the time the product is sold. Shorter processes have been developed, but these either require special machinery or make an inferior product and are not expected to completely displace the older method. Special precautions are necessary to prevent the poisoning of employees and rigid regulations have been enforced in many European countries, and since 1915 the manufacture of white lead has been prohibited in France. Factory inspection and dust control in the United States are such that the manufacture in this country is not attended by any injury to the health of the workers.

There has been a great deal of consolidation in the industry and this has resulted in the development of several very large paint companies. These companies are apparently wholly independent. The largest producer is the National Lead Co., which is a highly integrated corporation specializing in all kinds of lead products, but with diverse minor interests. The other concerns are mostly general paint companies. Only the smaller paint manufacturers buy dry white lead and nearly three-fourths of the output is consumed in the establishments in which it is produced and marketed in the form of paste or in mixed paint.

Except for a small quantity of English white lead in oil, foreign white lead has not been a factor in the domestic market for many years. The imports of this special quality increased from about 500,000 pounds in 1900 and in 1901 to around 650,000 annually just prior to the outbreak of the war in Europe. Due to the diffi-

culty of ocean shipment and the shortage of lead across the Atlantic the imports dropped off during the war period. Only 787 pounds were imported in 1918.

Prior to the war the average exports of white lead of American manufacture had increased to about 8,000 tons annually. Nearly two-thirds of this was shipped to Great Britain. Since 1914 the exports have increased very largely and in 1916 were 50 per cent higher than the prewar level. The increase has come chiefly from the development of trade with Latin American countries that had formerly been supplied by England and Germany. The American product is accepted on the same parity as the European in foreign markets, and there is every reason to believe that the American pigment can be delivered as cheaply in South American and Cuban markets as the white lead produced in any country. Spanish-speaking countries are using much greater quantities of paint and domestic manufacturers of white lead are directing more attention to South America.

The advantage that the American manufacturer has in the near-by foreign markets does not apply to his home market except as the latter is protected by tariff duties. The chief item in the cost of white lead is the cost of the lead metal used in its manufacture. The normal yield of white lead is in the neighborhood of 125 pounds for each 100 pounds of lead and the selling price of white lead (dry) is normally a trifle less than 1 cent more than the price of metallic lead. With the exception of a brief interval in 1913–14, metallic lead had been more expensive in the United States than in Europe until some time after the outbreak of the war. Mexican lead, which now promises to be the cheapest lead in the world, is largely refined (in bond) in this country. It can therefore be obtained more cheaply in the United States than anywhere else in the world provided it does not have to pay duty. The strength of the American export trade rests upon the availability of this cheap supply of raw material, which can be corroded in bond or exported with benefit of drawback.

The tariff problem in connection with white lead is largely that of adjusting a duty compensatory for the duty on lead metal. The quantity of other raw materials is small and they are practically as cheap in this country as anywhere and labor charges are a relatively small item.

White lead—Summary table.

Calendar year.	Domestic production.	Imports for consumption.	Domestic exports.	Ratio to production.	
				Imports.	Exports.
	Short tons.	*Short tons.*	*Short tons.*	*Per cent.*	*Per cent.*
1910	134,276	334	(1)	0.25	(?)
1911	132,612	371	(1)	.28	(?)
1912	146,833	344	(1)	.24	(?)
1913	142,626	336	7,531	.24	5.28
1914	159,474	298	8,823	.19	5.53
1915	156,101	120	12,655	.08	8.10
1916	128,979	44	13,718	.03	10.65
1917	115,200	10	9,869	.....	.....
1918	.....	[2] 309	7,795	.....	.....
1919	.....	.....	14,017	.....	.....

White lead—Summary table—Continued.

Calendar year.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity (cents per pound).	Equivalent ad valorem rate.
				Per cent.
1910	$38,919	$17,151.30	5.66	44.1
1911	46,213	18,526.78	6.23	40.0
1912	46,494	17,292.63	6.76	37.2
1913	45,266	15,057.73	6.73	33.2
1914	40,213	10,053.25	6.73	25.0
1915	24,608	6,152.00	10.29	25.0
1916	8,050	2,012.50	9.09	25.0
1917	1,965	491.25	9.71	25.0
1918	158	39.55	51.13	25.0

[1] Included in "All other" prior to July 1, 1912. [2] Pounds.

General Information.

PAR. 56, TARIFF ACT OF 1913.

"Lead pigments: Litharge, orange mineral, red lead, *white lead*, and all pigments containing lead, dry or in pulp, and ground or mixed with oil or water, not specially provided for in this section, 25 per centum ad valorem."

NOTE.—This survey covers white lead and sublimed white lead. The other lead compounds referred to in this paragraph are discussed in a survey of this series under the title "Oxides of lead."

DESCRIPTION.

White lead (Bleiweiss, ceruse, Blanc de Plomb, basic carbonate white lead, corroded white lead, Flake white, Krems white, etc.) is an artificial white pigment consisting of a mixture of carbonate and hydroxide of lead.[1] It should be distinguished from sublimed white lead, which is a basic sulphate of lead and has slightly different physical properties.

Basic carbonate white lead is the oldest of all the white pigments used in paints, and prior to the middle of the nineteenth century was practically the only white pigment used. It is still the most important pigment—either white or colored—and is in great favor with the practical painter because it can be easily spread and has great covering power. Its durability, however, is greatly improved when it is mixed with other pigments. Used alone white lead tends to "chalk" or dust off, due to its drying action on the oil. Another disadvantage is discoloration when exposed to the action of atmospheres containing sulphureted hydrogen. While it is regarded as a poisonous pigment, white lead is in no way dangerous except to the workman in factories where it is made or to the painter who applies it without proper precautions. On a painted surface it has no toxic effect.

[1] The formula is generally given as $2PbCO_3.Pb(OH)_2$. The valuable properties depend upon the content of lead hydroxide, $Pb(OH)_2$, which varies slightly, depending upon the process used for the manufacture of the white lead. The limits of hydroxide content of commercial white lead are 15 and 30 per cent.

USES.

White lead is a constituent of almost all mixed paints. In addition to its use as a pigment in paints, its easy solubility makes it also useful for the production of other lead compounds and salts.

SUBSTITUTES.

It was formerly believed that the substitution of any other material for white lead was an adulteration. At the present time, however, it is generally appreciated that the best results are to be obtained from a mixture of two or more pigments in a paint rather than by using one pigment alone. A large number of products have been heralded as substitutes for white lead, but most of these can perhaps be more accurately described as "supplements," in that, when mixed with white lead, they result in a paint that does not chalk off, is more resistant to the weather, and yields a surface that can be more easily repainted. The most important white pigments other than white lead are zinc oxide and lithopone (also a zinc compound). Barium sulphate in some form is almost as important as an ingredient of mixed paints. Sublimed white lead is a little more in the nature of a true substitute, as is also an oxychloride of lead, $PbCl_2.PbO$ or PbCl(OH). The former is an important pigment, especially in the United States, but the latter is no longer manufactured.

Less important substitutes or accessory white pigments are: Magnesium oxide, zirconium oxide, silica, asbestine, tin oxide, titanium dioxide, antimony oxide, bismuth oxychloride, barium tungstate, and calcium tungstate.

DOMESTIC PRODUCTION.

The total domestic output of dry white lead in 1914 was 279,269,860 pounds, of which three-fourths was consumed in the establishments producing it and marketed in paste form or made into paint. The total production in 1914 shows a gain of 12.6 per cent as compared with 1909 and 16.3 per cent as compared with 1904.[1]

Raw materials.—Pig lead is the raw material of prime importance in the manufacture of white lead. The other raw materials vary somewhat with the process of manufacture, but always include acetic acid and generally include tan bark.

The United States is independent as regards a supply of lead, and through bonded smelting arrangements and drawback privileges domestic consumers can draw upon the large Mexican resources for their export business without payment of duty. Since this Mexican lead is generally sold in Europe, it can be obtained in this country cheaper than anywhere else in the world, provided the articles manufactured from it are exported.[2]

Acetic acid is produced on a large scale in this country by the decomposition of calcium acetate. The acetate is almost wholly derived from the distillation of wood.

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[1] Census of Manufactures, 1914, Bureau of Census.

[2] That this is an important feature is indicated by the statistics for 1915 (fiscal year), when drawback was claimed on 14,054,901 pounds of white lead containing more than 10,000,000 pounds of foreign lead. The duties refunded amounted to $57,836.15. In 1913 and 1914 duties were refunded on over 60 per cent of the lead contained in the white lead exported in those years. Smaller amounts are also found in mixed paints exported.

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Spent tan bark, which is used especially in the Dutch process (as source of carbon dioxide), is the bark of oak trees which has already been used in the tanning industry. It is in ample supply in the United States.

A few establishments purchase acetate or subacetate of lead instead of pig lead and acetic acid or vinegar. Others use lead oxides. These slight differences, however, do not alter the situation. The domestic manufacturer is quite favorably situated as regards his supply of raw materials, especially for the export market, for which he can secure his lead at less cost than any foreign manufacturer. In the home market the higher cost of his metal is compensated for by the duty on his product.

Process of manufacture.[1]—The processes that can be used for the manufacture of white lead are many and varied. Even the elementary books on chemistry discuss from four to five. But in this country only two processes need be considered.

One of these is the Dutch process. This is the oldest and still the most largely used process for the production of white lead, since it results in a better product. This process, however, is exceedingly slow. Over 90 days are required. Briefly stated, it consists in the slow corrosion of metallic lead by means of acetic acid and the conversion of the material into hydrated carbonate of lead (with the regeneration of the acetic acid) by means of carbon dioxide gas. The lead is cast into "buckles," which expose the maximum surface to corrosion. These buckles are placed in clay pots containing dilute acetic acid or vinegar and the pots are stacked in tiers and covered with tan bark. The carbon dioxide required for the ultimate conversion of the corroded lead is generated by the action of the fermenting bark. Extremely little labor is required during the process and even making up of the tiers and tearing them down do not require many employees.[2] The buckles are not always corroded completely, so they must be cleaned in revolving drums and the white carbonate is ground and floated to separate impurities before it is dried and packed for shipment or ground in oil for use in the plant. From 125 to 129 pounds of white lead should be obtained from 100 pounds of metal.

The other process is the so-called quick process. This is more strictly a general term applied to quite a group of processes differing slightly from one another in detail. In most of these processes finely powdered (atomized) lead is used. In the Carter process the atomized lead is treated with acetic acid and carbon dioxide in revolving drums. In the "mild process" the finely powdered lead is suspended in water. Air blown into this suspension aids in the formation of basic hydroxide of lead, which is later converted partially to basic carbonate by blowing in carbon dioxide gas instead of air. The latter process is claimed by some to make an even purer pigment than the standard Dutch process. On the other hand, there are those that claim that the Dutch process makes the only thoroughly satisfactory white lead.

When proper precautions are taken there is no danger of lead poisoning among employees of white-lead works. In some fac-

[1] The details of the various manufacturing processes will be found in nearly every work on Industrial Chemistry.

[2] This, however, is a tedious operation.

tories the workmen are required to drink water that contains a little potassium iodide, which acts as a preventive. But the most care must be exercised by the management to avoid flying dust containing lead and which can be breathed by the workmen. In former times great misery was caused in white-lead factories. Charles Dickens referred to such an example and expressed the hope, which now has happily been fulfilled, that American ingenuity would overcome the dangers which beset the men.[1] Nevertheless, the manufacture of dry white lead as well as its use except in oil has been forbidden in France since 1915.[2] Stringent regulations are in force in other countries.

Organization.—According to Bureau of the Census, 20 establishments were engaged in the manufacture of white lead in 1914. Two of these consumed all of their own product in their own works, whereas the remaining 18 marketed all or part of their product in the dry form. The number of establishments engaged in the grinding of white lead in oil and marketing it in paste form or as paint was 214 in that same year. The latter establishments include practically all of the former, as nearly all the manufacturers of dry white lead make and sell white lead in oil. Most of these manufacturers are large concerns. Smaller concerns buy their supplies of white lead either in the dry form and grind it with oil or purchase the paste and simply mix the other ingredients and pigments for the preparation of finished paint.

Referring to the census figures of production it will be noted that the total output of dry white lead for sale has decreased from 123,070,000 pounds in 1899 to 71,643,812 pounds in 1914. On the other hand, the quantity made and consumed at the establishments where it was produced increased very largely during this period.[3] These figures are indicative of the growing tendency toward integration in the paint industry.

The Dutch process, because of the large amount of material in process of manufacture (i. e., due to the slowness of the process) calls for rather large working capital.

Localities of production.—Illinois, New York, Pennsylvania, Ohio, Missouri, and New Jersey, in the order named, were the leading producing States in 1914.[4]

History.—Native lead carbonate (cerussite) was used by the Romans as a paint pigment. The production of artificial white lead dates back at least to 1622, when references were made to the Dutch process.[5] It is probable that this original and still standard process originated in Holland, but it rapidly spread over the rest of Europe. Many processes have been developed with the hope of making a whiter product or with the view of reducing the time required. None of them, however, have been very successful.

The domestic manufacture was commenced in 1804. Prior to that date the United States had imported all of its supply of white lead, most of which was of a very cheap quality and highly adulterated.

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[1] "A Bright Star in the East" (short story). This reference is also cited by Toch (Chemistry and Technology of Paints, Van Nostrand, 1916).

[2] Rogers, Industrial Chemistry, p. 318: Van Nostrand, 1915.

[3] 131,622,000 pounds in 1899 and 207,626,018 pounds in 1914.

[4] Bureau of the Census figures. The United States Geological Survey reports for the same year show that a total production of 159,474 tons was produced by four firms in Pennsylvania, three firms in Illinois, two firms each in California and New York, and by one firm each in Michigan, Missouri, Nebraska, New Jersey, and Ohio. It further states that the two New York plants produce more than all the other plants put together.

[5] Thorp: Outlines of Industrial Chemistry.

In 1830, 12 establishments were reported as making white lead. Eight of these were situated east of the Alleghenies. The production in that year was 3,000 tons, as compared with 369 tons in 1810. and 15,000 tons in 1860. In 1870 the domestic output was 35,000 tons. Another great increase in production came in the decade 1880 to 1890. The production in the former year was 50,000 tons; in the latter 75,000.[1] Since 1900 the industry has suffered from the competition of zinc oxide and the increased use of barium sulphate fillers. In spite of the increased consumption of paint, the productions of white lead (as reported by the census) in 1904 and 1909 are less than the production in 1899. But in 1914 the largest output in the history of the industry was reported, although the ratio of white lead to the total paint consumed was but a fraction of what it was in 1899.

During the war period the output of white lead suffered in common with other paint pigments from the curtailment of building frame dwellings. The extraordinary prices for metallic lead and linseed oil resulting in higher prices for the product were another factor in the reduction of output.

Domestic production and consumption.—The production of white lead has exceeded the consumption in the United States for many years. In 1913 the domestic consumption was approximately 135,000 short tons, of which less than one-quarter of 1 per cent was imported. Exports of domestic product in the same year amounted to some 7,500 short tons.

Domestic exports.—Statistics of exports of white lead are not published separately by the Department of Commerce prior to July 1, 1912. The comparative uniformity of the domestic production and importations for some time before and for a short time after that date would indicate that the average exports prior to the outbreak of the war were in the neighborhood of 8,000 tons annually, about two-thirds of which was shipped to Great Britain.

Shortly after the outbreak of the war in Europe the exports of white lead increased very largely. In 1916 over 12,000 tons of white lead were shipped abroad or over 50 per cent more than the prewar average. The increase came largely from the development of trade with Latin American countries which had formerly been supplied by Great Britain and other European countries, expecially Germany. Canada also demanded more of this pigment, but the Canadian trade, which had formerly been almost wholly with the mother country, has never been large. In the early years of the war and prior to the entrance of the United States into the world conflict the exports to Great Britain increased, but in the latter part of 1917 and in 1918 the difficulty of ocean shipment reduced the exports to European countries and white lead was on the British list of prohibited imports.

FOREIGN PRODUCTION.

White lead is manufactured in practically all the important European countries, including Great Britain, Germany, France, Austria-Hungary, Russia, Italy, Belgium, Holland, and doubtless

[1] These statistics are from W. P. Thompson. One Hundred years of American Commerce, 1895, p. 436

others. A large factory was erected in Australia in 1917.[1] The quality of the product and the appearance are claimed to be equal to the best of the English white lead that formerly held that market.

No production data of foreign countries have been obtained. On a later page, however, will be found the foreign trade statistics of several of the more important European countries. France prohibited the further manufacture of white lead in its borders in 1915. Factory regulations in Great Britain have been quite rigid. In Germany, also, women and children are forbidden as employees. Workmen must be provided with facilities for keeping themselves scrupulously clean and are not permitted to work more than eight hours. In short, the labor situation with respect to the white lead industry is somewhat different than it is in many or most other lines of manufacture.

There is a large grinding industry in Great Britain. It will be noted that the prewar imports of white lead were in the vicinity of 300,000 hundredweight annually. The exports (most of which were to British possessions) averaged approximately 350,000 hundredweight. The value of the exports, however, was nearly 50 per cent greater. The explanation is that most of the imported material was dry and was ground in oil in British establishments and then packed for reshipment. A small amount of this material is sent back to the United States and is regularly quoted in the New York market at a higher price than the home product.

IMPORTS.

In the early history of the United States white lead was imported in comparatively large quantities. But it is a great many years since imported lead has been an active competitive factor in the domestic market. Most of that which is imported is of English origin.[2] The declaration values are very slightly lower than the price of American white lead in oil. So far as can be determined, all of this imported material is ground in oil and is imported because of the preference of consumers for special qualities rather than because it is cheap. In fact, as has been stated above, it is more expensive.

Little fluctuation is noted in the quantity or value of the white lead imported annually between 1900 and 1914.[3] The quantity dropped to less than 400,000 pounds in 1901 and rose to over 700,000 pounds in 1912.[4] In general, however, this period shows a gradual increase in the quantity (imported) from about 500,000 pounds at the beginning of the twentieth century to around 650,000 pounds just previous to the tariff change of 1913—a quite normal increase in the consumption of a specialized article. Following the reduction in the duty there was no increase in the amount of imports, and as the submarine menace developed after the outbreak of the war the

[1] Comm. Rept., Jan. 12, 1918. The cost of land and buildings is given as £60,000 and the cost of plant and machinery was £30,000 additional. It is further stated that this is not the first attempt to produce the pigment in Australia, several previous projects for making basic carbonate having failed. There is an establishment at Southwark, Adelaide, however, which has successfully manufactured basic sulphate white lead for several years.

[2] But see above as regards British exports.

[3] The references under this topic are to fiscal years.

[4] In spite of rather higher values per unit of quantity.

imports dropped off rapidly.[1] In 1918 the importation was only 787 pounds.

Revenue.—The amount of duty collected annually on white lead under the tariff act of 1913 has been comparatively small. The maximum revenue under this act (expressed in terms of yearly income) was during the last nine months of the fiscal year 1914, when it was at the rate of $11,700 annually. This maximum, however, was less than the minimum receipts of any previous year (except 1901) for more than 20 years. Even the low duties under the act of 1894 resulted in much greater revenue on imports of this commodity because of the enormously increased amount imported during the period that that act was in force. The annual revenue under the tariff act of 1909 ranged from slightly less than $39,000 to nearly $47,000.

PRICES.

White lead is marketed both in the dry form and as paste. The latter is quoted as "white lead in oil." Standard quotations are for deliveries in casks containing 100 pounds each. Smaller containers and packages are in common use, but white lead in even 50-pound containers generally brings a higher price than in the larger lots. Quotations of dry white lead follow the major movements of the lead metal market, and normally range from ¾ to 1 cent per pound higher than the price of the metal in the same market (New York). This differential, however, is only approximate and applies only to yearly averages. White lead quotations are much more stable than are those of the metal and often remain unchanged for several months, while the metal market may fluctuate considerably. A basic explanation of the comparative steadiness of the white lead market is that the process of manufacture calls for the carrying of such large stocks of the metal—both in treatment and as reserve—that minor flurries are unnoticed. But the question of actual as distinguished from quoted prices also arises. The quotations (see infra) of this unit represent only the trend of the real market. It is quite probable that the prices quoted for the prewar period are not widely different from those that governed actual transactions. But even then concessions were made and during the war period, especially during the uncertain lead market of 1916, more concessions were granted.

Basic carbonate white lead in oil contains about 8 pounds, or a trifle more than 1 gallon, of linseed oil to each 100 pounds of paste.[2] Its price is therefore dependent partly upon the cost of linseed oil and partly upon the cost of dry lead. Fluctuations in the price of the latter, however, practically govern the market.[3] Before the war

[1] This fact does not necessarily imply that under normal conditions the reduction in the protection on this commodity (from the equivalent of 36 to 40 per cent to 25 per cent) would have had no effect. Just before the outbreak of the European war the price of lead metal and, naturally, of commodities made from lead was abnormally high. Whereas for more than 10 years lead had been sold in London at a price 1½ cents lower than the New York market, the metal sold cheaper in New York than anywhere else in the world for a few months in the latter part of 1913 and early in 1914.

[2] An average of at least 5 gallons more oil is necessary to put this paste in condition to use as paint.

[3] The margin between dry lead and lead in oil does not vary greatly except for extreme fluctuations in oil prices. The price of oil, however, fluctuates to such an extraordinary degree that it occasionally becomes an important factor in spite of the fact that it constitutes only one-twelfth of the weight of the product. In 1909 the price of oil increased from 65 cents to 98 cents per gallon. This corresponded to an increase of roughly one-third cent in the cost of the oil contained in 1 pound of white lead ground in oil. The price of the latter was increased only one-fourth cent and this increase was partly offset by a simultaneous increase of one-eighth cent in the price of dry white lead. The differential between the two products was 1½ cents at the beginning of the year and only 1⅜ cents at the end of the year. Again, in 1914 linseed oil was selling at less than 50 cents, while in 1918 it sold as high as $1.90 (very little oil at this price was used in the paint industry). The corresponding costs of oil in white lead paste are 0.5 and 2 cents per pound. The differentials in prices of the commodity as compared with dry lead were 1½ and 1⅜ (approximately) cents for the respective years. But in this connection the facts given below must also be considered.

the price of basic carbonate white lead in oil remained practically fixed at 1¼ cents higher per pound than the nominal price of dry white lead, rising and falling with the latter.[1] Dry lead ranged between 5 and 6 cents, averaging about 5¼. Domestic white lead in oil was quoted at 6½ to 7½ cents.[2] During the war period and while prices were advancing the differential narrowed. White lead in oil did not respond so rapidly to the increased cost of the metal and sold throughout 1916 and 1917 at only about 1 cent higher per pound than the dry pigment, which more than kept pace with the growing cost of the metal.[3]

The discounts allowed on large consignments of lead in oil were quite constant at one-fourth cent per pound for many years. This margin was accepted as reasonable on a staple of this class and was rarely departed from even on the largest orders until list prices rose above 7 cents. It was not until the price reached 12 cents (in April, 1918) that corroders adopted a system of charges that permitted a more liberal profit to all classes of dealers. In place of the flat reduction for large orders a sliding scale of discounts was arranged, ranging from 10 per cent off a list price of 12¼ cents on lots of from 500 to 2,000 pounds to 10 and 6 per cent on lots of over 30,000 pounds.

Foreign prices have not been investigated. According to Mineral Industry (1913), the London and New York markets are more nearly on a parity in the case of white lead than in any other lead commodity. Whether or not this is due to a possible superiority of the English product (which always sells at a higher price in the New York market) is not stated. However, in many foreign markets American white lead is accepted on a parity with European grades.

TARIFF HISTORY.

White lead, in common with other lead commodities, has been dutiable in all or nearly all tariff acts of the United States, and until the present act (1913) the modern tendency has been toward specific rather than ad valorem duties. The general trend of each succeeding act since 1883 has been to reduce the duty on this commodity. The one exception was the act of 1897, which increased the duty of all lead commodities to levels only a little lower than they were before the reductions of the act of 1894.

As stated above, the reductions of most of the tariff acts have had little effect upon the amounts imported and have generally resulted merely in a more or less reduced revenue to the Government.

COMPETITIVE CONDITIONS.

The manufacture of white lead hinges directly upon the lead industry. A reasonably cheap and adequate supply of this essential raw material is requisite to the successful conduct of any corroding

[1] This statement refers only to the decade immediately preceding the outbreak of the war. The differential had previously been somewhat greater. A factor that has tended to reduce the margin (especially since 1900 to 1905) has been the competition of mixed bases containing zinc oxide and/or barytes in addition to white lead. Dry white lead is purchased almost exclusively for the preparation of these mixed paints which actively compete with those made from pure white lead, and this fact tends to narrow the margin allowed by the manufacturers of the lead pigment.

[2] English white lead in oil was quite steady at 10½ cents per pound.

[3] Except during the period of extraordinary high prices in the summer of 1917. The average price of lead metal for five years before the war was 4¼ cents per pound (New York), or approximately 1 cent lower than the quotation for dry white lead. In 1916 the quotation of dry white lead was increased to 8¾ cents, whereas the metal averaged about 7 cents. In 1917 the metal advanced to over 11 cents in June and in July the price of dry lead jumped to 11½ cents, with the metal at 10¾. But when the metal came down dry white lead remained at high levels, frequently as much as 2 cents more than the metal quotations.

business. Under existing tariff protection on lead metal and ore domestic corroders have some advantage in the domestic market only so long as the protection on their product compensates for the generally higher cost of their raw material. Except for a comparatively short interval immediately before the outbreak of the European war, lead has been more expensive in the United States than in the large European countries. As regards minor chemicals, it now seems probable that the former advantage enjoyed by German and other European corroders has been reduced. The labor element also is not so important in the case of white lead as in products in which the cost is not so largely dependent upon the cost of raw material. In the case of a typical grade of white lead which contains about 81 per cent of metallic lead, the cost of the lead metal constitutes two-thirds of the selling price of the finished (dry) white lead.[1] Only one-third of a normal price of about 5¼ cents per pound (before the war) was left to cover the cost of acetic acid, equipment, operation, and other charges (including interest on stock on hand and on invested capital and profit).

The peculiar situation as regards export trade has been mentioned above. It would be quite possible for many corroders to carry on an export business successfully competing with foreign manufacturers in foreign markets and yet be unable to compete in the United States without tariff protection. This apparent anomaly is due to the drawback privilege which permits the return of 99 per cent of the duty on imported materials used in the manufacture of articles subsequently exported. This privilege opens a large supply of cheap Mexican lead which can be obtained more cheaply in the United States than elsewhere provided it does not have to pay the full duty (25 per cent in the act of 1913) as it would have to do when used for white lead intended for domestic consumption. The duty on white lead in recent years, however, has been fully compensatory for the duty on lead metal.

A factor, formerly much more important than it is at the present time, is the availability of extremely pure "soft" or silver-free lead derived from ores found in quantity only in the Mississippi Valley. Lead made from such ores was formerly considered much superior to ordinary desilverized lead which comes from less pure ores. Refinements in metallurgy, however, have now advanced so that the metal made from ordinary ores is quite as desirable for corroding purposes as is the so-called "soft" lead.[2]

SUBLIMED WHITE LEAD.

Basic lead sulphate ("sublimed white lead" or "oxysulphate") is an amorphous white pigment with excellent covering and hiding properties. It is very fine and uniform in grain and has a somewhat greater resistance to discoloration than basic carbonate white lead. It is a somewhat cheaper product than the latter as it is manufactured direct from lead ore, whereas the basic carbonate is made almost

[1] This statement is based upon the assumption that the normal prices of white lead and of lead metal are the 1909–1914 averages, 5¼ and 4¼ cents per pound, respectively. In which case, of course, the cost of metal required to make 100 pounds of dry white lead is 81 (per cent) × $0.04¼ = $3.45, or 66 per cent of $5.25, the price of the product.

[2] In the last few years a considerable tonnage of the Missouri soft lead has been desilverized (refined) like metal from western ore. The chief argument for this extra treatment (since the silver recovered is not sufficient to pay the cost of the operation) is that it makes a better product for corroding, a conclusive evidence of the improvements in lead refining.

exclusively from lead metal. The composition is approximately 75 per cent lead sulphate, 20 per cent of lead oxide, and 5 per cent zinc oxide. It is the only white pigment that contains any appreciable amounts of lead oxide and it must be carefully distinguished from ordinary lead sulphate which is a comparatively poor pigment material. It somewhat resembles leaded zinc oxide in composition and mode of manufacture. The properties, like those of other pigments made direct from ore, depend upon the care exercised in the manufacturing process. It has a tendency to spread too thin in paint and must be mixed with coarser material to give it "tooth."

Basic sulphate white lead is used extensively in paints and in the manufacture of oilcloth, stained paper, and rubber goods. The following quotation is from Toch: [1]

> Among 100 reputable paint manufacturers in the United States, 65 used sublimed white lead. About 8,000 tons were used in 1905 * * * it is very likely, judging from its qualities, that it will be used more universally and in larger quantities in the future.

The raw material is silver-free galena (lead sulphide ore) from the Missouri fields. It is ground fine, mixed with carbon, and heated in a furnace similar to the ore-hearth commonly used in the production of metallic lead from these same ores. The furnace products are (1) waste slag, (2) sublimed white lead, and (3) a little lead metal. The pigment is collected in bag houses. Blue fume or "sublimed blue lead" is a by-product of the process. This material has a peculiar bluish gray color and is used in the same industries as the major product.[2]

The Picher Lead Co., of Joplin, Mo., commenced the manufacture and sale of this product in 1902. It registered the name "sublimed white lead." A few years later, the St. Louis Smelting & Refining Co. (National Lead) also began to make this pigment and sold it under the name of "basic lead sulphate."

Both of the American plants are very similar in their general arrangements and have been described in the literature.[3] According to Buskett, the requisite investment for a plant capable of treating 40 tons a day is about $100,000. The salable products should be 35,500 pounds of pig lead and 35,000 pounds of pigment. Assuming an average price of 4.5 cents per pound for the former and 5.5 cents per pound for the latter, the total value of the products is $3,522.50. The daily operating expense is estimated at $2,625.55, which leaves a daily profit (on a plant of this size) of $896.95. This gross profit, however, includes selling costs, interest, amortization, and repairs.

The first year's production of the Picher Lead Co. (1902) was 4,733 short tons of "sublimed white lead," valued at $449,611. In 1909 the combined output of both the companies making lead pigments direct from the ore was as follows:

	Short tons.	Value.
Sublimed white lead	9,915	$1,070,820
Sublimed blue lead	981	101,043
Total	10,896	1,171,863

[1] Chemistry and Technology of Paints. Van Nostrand, 1916.

[2] Sublimed blue lead consists of lead sulphate 50 to 53 per cent, lead oxide 41 to 38 per cent, with small proportions of lead sulphide, lead sulphite, zinc oxide, and carbon.

[3] Especially Buskett: Min. Eng. World, 1911, xxxv, p. 57 and Ibid, 1912, xxxvi, p. 393. Also Hofman, H. O.: Metallurgy of Lead, McGraw-Hill, 1918.

The total output in 1910 was 9,951 short tons, valued at $1,002,010, an average of $100.69. These figures [1] show a decrease in quantity and also a decrease of $6.86 per ton in the value as compared with 1909. These data are the last published figures. The outputs since 1910, while reported annually to the Geological Survey, are included with other lead pigments made direct from ore (chiefly leaded zinc oxides) in published statements in order to avoid disclosing individual returns. In general it may be said that the present productions are considerably in excess of the above figures.

The price of sublimed white lead generally rules about 1 cent per pound lower than that of basic carbonate white lead. So far as reported, no basic sulphate white lead is either imported or exported (except, perhaps, in the form of ready-mixed paints). If imported, it would be classified with ordinary white lead, probably without question.

There is one plant for making this pigment in England (Bristol Sublimed Lead Co.) and one in Australia.

White lead—Production in United States—States and cities.

[From Federal census.]

States or cities.	1909		1914	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
California: Oil [a]	12,987,067	$806,699	11,635,836	$711,944
Illinois:				
Oil	53,053,691	3,397,798	73,019,593	5,000,591
Dry [a]	13,832,932	688,317	16,783,007	950,147
Maryland: Oil [a]			1,598,572	133,229
Massachusetts:				
Oil [a]	3,834,462	218,994	2,914,735	171,563
Missouri: Oil [c]	40,755,680	2,410,387		
Dry [b]	4,352,226	227,139	34,389,924	2,180,674
Michigan:				
Oil [a]			2,317,265	140,463
New Jersey: Oil [c]	3,713,557	253,308		
Dry [b]	16,958,467	580,567	12,210,626	668,300
New York:				
Oil [a]	62,973,138	3,765,227	63,805,600	3,795,370
Dry [b]	12,173,520	639,841	12,341,619	631,642
Ohio:				
Dry [b]	11,808,277	603,098		
Oil [a]	24,057,529	1,532,797	29,011,498	1,910,042
Pennsylvania:				
Oil [a]	32,401,207	1,995,179	41,526,000	2,470,052
Dry [b]	18,414,107	890,607	10,295,241	517,772
Indiana: Oil [c]			832,890	53,369
All other:				
Oil [a]	12,791,239	854,022		
Dry [b]	7,694,885	292,234	32,223,945	1,598,141
Total:				
Oil [a]	246,567,570	15,234,411	281,417,563	18,141,444
Dry [b]	85,234,414	3,921,803	71,643,812	3,697,702

[a] Production of white lead ground in oil, in paste form.
[b] Production, for sale, of white lead, dry.
[c] Mineral Resources. U. S. Geological Survey.

[1] Mineral Resources. U. S. Geological Survey.

White lead—Production in United States—Official source.

[From Federal census.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
~~1899~~:	*Pounds.*		1909:	*Pounds.*	
Dry	254,692,000	[1] $9,314,086	Dry	247,971,503	[1] $11,406,689
Oil	119,012,000	6,127,960	Oil	246,569,970	15,234,539
1904:			1914:		
Dry	240,092,000	[1] 11,070,642	Dry	279,269,860	[1] 14,410,324
Oil	229,622,000	11,789,982	Oil	281,417,563	18,141,444

[From Mineral Industry, U. S. Geological Survey, since 1910.]

	Short tons.			*Short tons.*	
1900 [2]	96,408	$9,910,742	1913	142,626	$18,112,219
1904 [2]	126,336	13,896,913	1914	159,474	19,943,239
1909 [2]	131,643	12,652,638	1915	156,101	19,393,691
1910	134,276	13,024,762	1916	128,979	21,274,480
1911	132,612	17,393,241	1917	115,200	22,529,831
1912	146,833	18,683,461	1918	102,888	20,766,848
			1919	139,090	26,425,022

[1] Values of dry white lead estimated on amounts sold.
[2] 1904–1910 does not include sub-limed white lead.

White lead—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	2¾ cents per pound.	617,507	$38,482	$17,753	$0.062	46.13
1908	....do....	513,099	31,603	14,751	.062	46.67
1909	....do....	667,417	37,493	19,188	.056	51.18
1910	....do....	32,505	1,649	934	.051	56.67
1910	2¼ cents per pound.	695,926	39,154	17,398	.056	44.43
1911	....do....	659,915	38,878	16,497	.059	42.44
1912	....do....	713,370	46,919	17,834	.066	38.01
1913	....do....	676,558	46,380	16,913	.069	36.47
1914	....do....	131,807	9,069	3,295	.069	36.34
1914	25 per cent	520,597	35,106	8,776	.067	25.00
1915	....do....	514,876	36,743	8,935	.069	25.00
1916	....do....	153,474	11,970	2,992	.078	25.00
1917	....do....	57,045	5,654	1,413	.099	25.00
1918	....do....	787	239	59	.304	25.00
1919	....do....	21,153	2,477	619	.117	25.00

White lead—Domestic exports.

FISCAL YEARS.

Exported to—	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Austria-Hungary	34,545	$2,072	11,453	$687	.....	.....
Belgium	1,106,961	66,220	1,402,903	84,195	89,496	$4,699
France	.....	.....	16,598	1,283	192,873	10,172
Germany	737,167	44,230	1,279,909	76,796	72,794	4,368
Italy	298,109	17,501	71,525	4,291	.....	.....
Netherlands	857,679	50,917	936,054	56,150	283,818	15,533
United Kingdom [1]	11,009,896	658,641	11,066,867	661,939	14,799,864	782,739
Canada	148,241	7,807	96,986	4,973	222,001	11,638
Central American States	488,166	30,026	805,767	48,797	595,562	39,466
Argentina	16,500	990	100,679	5,945	1,180,397	60,876
All other	1,039,224	65,801	2,375,121	63,149	2,263,375	141,155
Total	15,736,488	944,205	16,845,154	1,013,506	19,700,180	1,070,646

[1] England and Scotland.

White lead—Domestic exports—Continued.

FISCAL YEARS—Continued.

Exported to—	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Austria-Hungary						
Belgium						
France	1,308,004	$80,698	635,531	$62,262	142,469	$13,907
Germany						
Italy					5,500	579
Netherlands			198,440	16,594		
United Kingdom [1]	18,247,374	1,093,872	11,514,101	981,805	1,996,292	181,921
Canada	369,882	21,329	469,714	39,527	513,360	47,636
Central American States	675,332	46,252	1,044,618	96,123	798,297	92,610
Argentina	2,737,658	196,209	1,267,243	148,118	3,132,663	414,767
All other	5,472,274	406,431	6,259,291	599,716	11,647,202	1,320,932
Total	29,107,449	1,861,730	21,388,938	1,944,145	18,235,783	2,072,352

[1] England and Scotland.

CALENDAR YEARS.

Exported to—	1918		1919	
	Pounds.	Value.	Pounds.	Value.
Belgium			1,136,525	$111,970
France	404,737	$37,999	3,620,235	375,284
England			7,309,382	742,257
Scotland			3,358,555	326,288
Argentina	2,459,694	301,775	2,920,965	398,022
British India	1,125,782	122,951	460,676	57,706
Australia	2,755,346	307,669	1,293,987	135,756
New Zealand	1,261,359	151,945	704,435	77,731
Philippines	1,286,625	146,799	813,369	97,330
All other				
Total	15,588,916	1,756,739	28,033,485	3,037,292

White lead, prices, wholesale, New York, spot, in cents per pound.

[From Oil, Paint, and Drug Reporter.]

Kinds or grades.	Basic carbonate.			American, dry, basic sulphate.	Kinds or grades.	Basic carbonate.			American, dry, basic sulphate.
	American, dry.	American, in oil.	English, in oil.			American, dry.	American, in oil.	English, in oil.	
1912.					1916.				
January	5½	7½	10½	.....	January	6½	7½	12	6
April	5½	6¾	10½	.....	April	8¾	9¾	12	.....
July	5¼	7	10½	5 - 5½	July	8¾	9¾	12	.....
October	5¾	7¼	10½	.....	October	8¾	9¾	12	.....
1913.					1917.				
January	5½	7	10½	.....	January	8¾	9¾	12	8½
April	5½	6¾	10½	.....	April	9½	10½	12	.....
July	5½	6¾	10½	.....	July	11½	12¾	12½	.....
October	5¾	7½	.....	.....	October	10	11¾	(1)	.....
1914.					1918.				
January	5½	6¾	10½	.....	January	9 -10	10½-11	12	8½-9
April	5½	6¾	10½	.....	April	9 -10	10½-11	12	8½-9
July	5½	6¾	10½	.....	July	9½-10½	.....	.....	9 -9½
October	5½	6¾	10½	.....	October	9½-10	11½	.....	9 -9½
1915.					1919.				
January	5	6¾	10½	.....	January	10 -10½	.....	12	9½-9¾
April	5½	6¾	12	.....	April	9 - 9½	[2] 13	.....	8½-8¾
July	5	6¾	12	.....	July	9 - 9½	[2] 13	.....	8½-8¾
October	5¾	6¾	12	.....	October	9 - 9½	[2] 13	.....	8½-8¾

[1] Nominal.

[2] 100-pound kegs less than 500 pounds.

White lead, prices wholesale, New York, spot, in cents per pound—Continued.

	Basic.		White lead in oil.	
	Carbonate, American, dry.	Sulphate.	Less than 500 pounds.	Car lot or over 500 pounds.
1920.				
January	9 - 9½	8½- 9	14.50	12.14
April	10½-11	9½-10½	15.50	12.98
July	10½-11	10 -10½	15.50	12.98
October	10½-11	10 -10½	15.50	12.98

White lead (par. 56, 25 per cent)—Rates of duty.

Act of—	Schedule.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	4	When dry or in pulp, when ground or mixed in oil	3 cents per pound.
1890	67	White lead and white paint containing lead, dry or in pulp, or ground or mixed with oil.	Do.
1894	52	White lead, and white paint and pigment containing lead dry or in pulp or ground or mixed with oil.	1½ cents per pound.
1897	55	Same as 1894	2½ cents per pound.
1909	53	....do	2½ cents per pound.
1913	56	White lead and all pigments containing lead, dry or in pulp and ground or mixed with oil or water.	25 per cent.

COURT AND TREASURY DECISIONS.

Decision under the act of 1894.

Black pigment containing lead held dutiable as a pigment containing lead and not as pigment not specifically provided for. There being a doubt whether "white" describes and limits "pigment," the doubt is resolved in favor of the importer (T. D. 16819, G. H. 3338).

MISCELLANEOUS.

White lead (from official publications unless otherwise noted)—Trade of principal foreign countries.

IMPORTS.

Year.	United Kingdom.		Germany.		Austria, quantity.
	Quantity.	Value.	Quantity.	Value.	
	Hundredweight.		*Pounds.*		*Metric tons.*
1909			6,357,560	$228,960	57
1910			6,115,780	220,080	139
1911			8,663,380	321,360	108
1912			5,958,920	266,640	94
1913	321,323	£362,913	4,355,780	213,840	113
1914	282,642	337,591			
1915	174,502	233,380			
1916	160,209	314,079			
1917	51,718	112,256			

EXPORTS.

1909			23,383,040	$787,440	80
1910			29,907,680	1,141,920	510
1911			32,915,300	1,234,800	35
1912			28,050,660	1,230,480	82
1913	367,854	£504,729	27,285,280	1,372,800	32
1914	384,982	534,770			
1915	310,412	480,652			
1916	262,250	569,319			
1917	104,708	259,821			

LEAD ACETATE, LEAD NITRATE, AND OTHER LEAD COMPOUNDS, N. S. P. F.

[Par. 57, act of 1913.]

GENERAL INFORMATION.

Lead, acetate of, white, and nitrate of, 1½ cents per pound; acetate of, brown, gray, or yellow, 1 cent per pound; all other lead compounds not specially provided for in this section, 25 per cent ad valorem.

DESCRIPTION.

Lead enters into combination with most of the mineral and organic acids to form salts. Some 77 of these compounds are listed in the chemical dictionaries; but only two—lead acetate and lead nitrate—are of any considerable commercial importance. These two salts are the only common compounds of lead that are at all readily soluble in water, and one or the other is generally employed when a solution containing lead is required.

Lead acetate.—The acetate of lead, $Pb(C_2H_3O_2)_2.3H_2O$, often called "sugar of lead" because of its sweetish taste, is the most soluble of the common salts of lead. It is found on the market as (1) "white," or pure acetate of lead, and (2) "brown" (also "gray" or "yellow"), which is more or less discolored by impurities. Each of these qualities is obtainable in two grades which differ in price by about 1 cent per pound. The more expensive quality of white acetate is known as "crystals"; the corresponding grade of brown acetate is called "granular." The cheaper quality of both grades is sold as "broken," "broken cakes." The best grade of white crystals contains practically the theoretical content of lead (54.7 per cent).

Lead acetate is one of the most important salts of lead. It is used especially in the manufacture of paints and varnishes, in the preparation of alum mordants for dyeing cloth, and in hair dyes. It is a valuable reagent in the chemical laboratory and is used to a considerable extent in medicine.[1] The basic acetate, $Pb(C_2H_3O_2)_2.2PbO.H_2O$ is used to some extent for weighting silk. The latter is prepared from the normal acetate which, in aqueous solution, will dissolve lead oxide quite readily, forming basic acetates or subacetates which contain a higher ratio of lead to acetate than the normal salt.

Lead nitrate.—The nitrate of lead, $Pb(NO_3)_2$, crystallizes without water and contains, when pure, 52.9 per cent of lead. It is not quite so soluble as the acetate but it is frequently used instead of the latter, particularly in case its nitrate content can be utilized in making a valuable by-product, since, as a general rule, its lead content is less costly than the same quantity of lead in the form of acetate. The nitrate content has caused this compound to be used to some extent in the manufacture of matches. The main consumption, however, is in dyeing and calico printing, for the production of mordants, and in making chrome yellow (lead chromate pigments).

[1] Generally as solution or paste containing the subacetate (Goulard water. Liquor plumbi subacetatis or Acetum Plumbum or Saturni) for the treatment of skin diseases and, internally, as an astringent.

Other lead compounds.—The oxides of lead and pigments containing lead have been described in other surveys of this series. The lead compounds referred to in paragraph 57 of the 1913 act consist wholly of lead salts, of which there is a wide variety, and lead compounds for use as chemical reagents and other special purposes. Descriptions of these salts will be found in any standard work on chemistry, and, as few of them are marketed in any considerable quantity, they will not be described here. The list of varieties imported in 1913–14, which is given on a later page of this Survey shows most of the salts that are of more than purely theoretical interest. Aside from chemical reagents, the chief consumption of these salts is in paint driers and for the manufacture of rubber.

METHODS OF PRODUCTION.

The most important raw material for the manufacture of lead compounds is, of course, the metal itself. In fact a large number of the consumers of lead salts purchase only the metal and manufacture the required salt as a step in their process—generally producing the acetate or nitrate as a preliminary operation and converting it to the desired compound by treatment with the requisite acids. Other manufacturers purchase litharge or massicot (lead oxide, PbO) or white lead residues as sources of the metal. The latter are acted upon much more rapidly than the metal itself and the production of the salts is much simplified.

For the production of lead acetate direct from the metal, the latter is granulated, feathered, or otherwise prepared so as to expose a maximum surface and then treated with pure acetic acid in contact with the air. Lead vessels are generally employed, although copper containers having a piece of lead soldered to them in order to protect the copper (by galvanic action) are occasionally used.[1] The presence of an ample supply of air assists in the dissolving action, which is conducted intermittently, the metal being first moistened with the acid, then allowed to stand and oxidize, and again treated with acid. The operation is repeated again and again until the metal is in solution. The latter is then evaporated (to a density of 1.5) and allowed to crystallize.

Litharge is commonly used instead of the metal. It requires only to be treated with the acid as it dissolves readily. About 3 parts of acetate are produced from 2 parts of litharge by weight.

In the production of "brown" sugar of lead, pyroligneous acid (crude acetic acid or wood vinegar) is used, the dark colored impurities contaminating the product.

Lead nitrate is made by dissolving litharge in hot dilute nitric acid, concentrating the solution and separating the crystals.

DOMESTIC PRODUCTION.

There are no statistics as to the separate productions of the several lead salts. The Federal Census reports that 7,290,936 pounds valued at $474,430 were produced in the United States in 1914. This amount, however, probably does not include a large part of the production that was consumed at the plants in which it was made.

[1] Thorpe. Dictionary of Applied Chemistry.

FOREIGN PRODUCTION.

The production of lead salts in foreign countries has not been investigated. Germany, before the war, was one of the largest producers; but Great Britain, Belgium, and France produced considerable quantities.

IMPORTS.[1]

The imports of lead salts in recent years have not been large and, since the outbreak of the war in Europe, have been almost negligible. Prior to 1910 the quantities of these salts, especially of the nitrate, were much greater than they have been at any time since that year. The maximum importation since 1910, as shown by the statistics, amounted to 242,624 pounds valued at $21,785 in the fiscal year 1914. This was the first year for which the figures for importations of lead salts other than the acetate and nitrate are separately recorded and, even the above figures do not include the imports of these miscellaneous salts for the first three months under the act of 1909. Since the imports of the latter salts for the remaining 9 months amounted to nearly one-half of the total, there is a possibility that if the data for previous years were available it would be found that the progressive decline in the quantities of acetate and nitrate of lead was paralleled in the case of the other lead salts. The maximum shown for 1914 was due to the inclusion of these other salts in the statistics.

The countries of origin of these articles are not published in Commerce and Navigation. But a report compiled by Dr. Pickrell of the Department of Commerce gives this information for the fiscal year 1914. The data pertaining to the lead salts are copied on page 130 of this survey. The imports of lead acetate in 1914 were derived chiefly from Great Britain, although considerable quantities were imported from Belgium, Germany, and Austria and a little from France. Great Britain (Scotland) was the main source of the nitrate imported in that year; only 2.6 per cent of the total 11,604 pounds of lead nitrate imported for consumption in 1914 came from Germany.

A total of 46 different lead compounds within the classification of paragraph 57 of the act of 1913 were imported in 1914. Referring to the table on page 15, it will be noted, however, that only 13 were imported in amounts greater than $100 in value. The remainder may be considered as consisting chiefly of reagents for use in chemical laboratories and derived in large part from Germany. The most important importations were of lead salts for use as driers in the manufacture of paint. The next largest importation was of lead hyposulphite which is used in rubber manufacture. The latter came chiefly from Germany; but Belgium supplied a considerable quantity and a small amount came from England.

The imports in 1918 consisted wholly of compounds not specially provided for. The amount was only 4,510 pounds valued at $242. There has been practically no acetate reported since 1915 and only about 1 ton of lead nitrate has been imported since the outbreak of the European war.

[1] The references under this topic are to fiscal years ending June 30.

PRICES.

The prices of lead acetate and lead nitrate practically doubled during the war period. Prior to 1914, the prices of these salts had followed closely the litharge market; but during the war period, the increased prices of acids also became a factor. The war-time fluctuations of litharge and the various lead salts are shown in the following table:

War-time prices of lead salts.[1]

[Cents per pound.]

Article.	August, 1914.	January, 1915.	January, 1916.	January, 1917.	January, 1918.	January, 1919.
Litharge	5½–5¾	5 –5¼	6½	9½	9½–11½	10¾–11½
Lead acetate:						
Brown, broken	7½–7¾	7½–7¾	10¾–11	11½	15 –15⅝	15⅝–16½
Brown, granular	8¾–9¼	8⅝–9¼	12½–12¾	12½–12¾	16¼–17¾	16¾–17¼
White, broken	8¾–9	8⅝–9	11¼–12¼	12¼	16½	16½–17
White, crystals	9¼–9⅝	9¼–9⅝	12⅝–17¼	13	17 –17½	17 –17½
Lead nitrate	7¾–8	8	13½–14	15½–16	Nominal.	[2] 15

[1] Quotations from Oil, Paint, and Drug Reporter except as otherwise noted.
[2] Quotation of Drug and Chemical Market.

TARIFF HISTORY.

Specific duties were placed on acetate of lead and nitrate of lead in the tariff act of 1883. The policy of specific rates has been followed in subsequent acts. Gray and yellow acetate of lead were mentioned in the act of 1897, being classed with brown acetate which had appeared in the former acts. "Other lead compounds" were mentioned in the paragraph of the 1913 act and made dutiable at 20 per cent ad valorem which was a slight reduction from the duty on these compounds under the act of 1909, which provided a duty of 25 per cent on all chemical compounds not specially provided for.

The duties on white acetate, brown acetate, and nitrate under the act of 1883 were 6, 4, and 3 cents per pound, respectively. These rates were progressively reduced in all the subsequent acts except that of 1897, which increased the duties of the act of 1894 but did not provide as high rates as the act of 1890.

In the act of 1913, both white acetate of lead and nitrate of lead were made dutiable at the same rate, 1¼ cents per pound, and the duty on brown, gray, or yellow acetate was reduced to 1 cent per pound. In former acts, white acetate had been dutiable at a higher rate than the nitrate.

A study of the imports of these articles since 1893 shows no marked effects of the successive tariff reductions upon the quantities imported with the exception of the act of 1894. The lower duties under that tariff were accompanied by greatly increased importations, especially of white acetate.

TARIFF CONSIDERATIONS.

The tariff problem relative to the compounds of lead included in paragraph 57 of the act of 1913 may be considered as a minor phase of the lead situation. Lead metal or the oxides derived from it constitutes the chief item of cost in most of these products. Domestic manufacturers are at little if any disadvantage as regards their

supply of acetic acid (calcium acetate) or nitric acid. The manufacturing process is not complicated.

Lead, however, and practically all articles made from lead are dutiable and their cost under normal conditions is a little greater in this country than in foreign markets.

Lead acetate, etc.—Production in United States—"Official source."

[Figures from Federal census.]

No data for years 1899, 1904, and 1909; in 1914 (listed as "Lead salts"; all other, except arsenate), the production was 7,290,936 pounds, valued at $474,430.

Lead, acetate of, white; paragraph 57, act of 1913; 1½ cents per pound—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	3½ cents per pound.	3,176	$268	$103	$0.840	38.52
1908	do	350	51	11	.146	22.33
1909	do	140	37	4	.264	12.35
1910	3 cents per pound.	9,437	526	283	.055	53.85
1911	do	2,476	141	74	.057	52.68
1912	do	36,165	1,880	1,084	.052	57.71
1913	do	21,599	1,177	647	.054	55.05
1914	do	66	15	1	.228	13.20
1914	1½ cents per pound.	110,870	10,753	1,385	.097	12.89
1915	do	31,096	1,809	388	.058	21.49
1916	do					
1917	do					
1918	do					
1919	do	220	212	3	.963	14.15

Lead, acetate of, brown, gray, or yellow; paragraph 57, act of 1913; 1 cent per pound—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	2¼ cents per pound.	16,891	$940	$380	$0.056	40.43
1908	do	11,719	736	263	.063	35.82
1909	do					
1910	2 cents per pound.	15,814	766	316	.049	41.29
1911	do	15,624	728	312	.047	42.89
1912	do	4,331	251	86	.058	34.51
1913	do	42	8		.190	10.50
1914	1 cent per pound.	17,477	957	174	.055	18.26
1915	do					
1916	do	124	17	1	.137	7.29
1917	[1]	225	97	1	.431	1.86

[1] From Cuba, 1 cent per pound less 20 per cent.

Lead, nitrate of; paragraph 57, act of 1913; 1¼ cents per pound; Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	2½ cents per pound.	277,382	$10,996	$6,935	$0.040	63.06
1908	....do....	221,355	11,797	5,533	.053	46.91
1909	....do....	208,365	9,051	5,209	.048	57.55
1910	....do....	33,600	1,624	840	.043	51.72
1910	2½ cents per pound.	98,107	5,136	2,207	.052	42.98
1911	....do....	166,325	8,623	3,742	.052	43 40
1912	....do....	169,932	8,822	3,823	.052	43.34
1913	....do....	11,305	605	254	.054	42.04
1914	1¼ cents per pound.	11,312	712	141	.063	19.86
1915	....do....					
1916	....do....	2,205	280	27	.126	9.84
1917	....do....	224	22	2	.098	12.73

All other lead compounds, n. s. p. f.; paragraph 57, act of 1913; 20 per cent ad valorem—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	20 per cent	102,899	$9,348	$1,869	$0.091	20.00
1915	....do....	86,514	7,471	1,494	.086	20.00
1916	....do....	39,823	3,644	728	.091	20.00
1917	....do....	32,887	3,069	613	.093	20.00
1918	....do....	4,510	242	48	.053	20.00
1919	....do....	2,408	321	64	.133	20.00

Lead, acetate, white, crystals; prices (wholesale) per pound, New York spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	9½–9¾	Jan. 3, 1916	12½–12¾
April 1, 1912	9½–9¾	Apr. 3, 1916	13½–13¾
July 1, 1912	9½–9¾	July 3, 1916	15½–15¾
Sept. 30, 1912	9½–9¾	Oct. 2, 1916	13½–
Dec. 30, 1912	9½–9¾	Oct. 1, 1917	17 –17½
Mar. 31, 1913	9½–9¾	Dec. 31, 1917	17 –17½
June 30, 1913	9½–9¾	January, 1918	17 –17½
Sept. 29, 1913	9½–9¾	April, 1918	17 –17½
Dec. 29, 1913	9½–9¾	July, 1918	17 –17½
Mar. 30, 1914	9½–9¾	October, 1918	17 –17½
June 29, 1914	9½–9¾	January, 1919	15½–16
Sept. 28, 1914	9½–9¾	April, 1919	14 –14½
Dec. 28, 1914	9½–9¾	July, 1919	14 –14½
Mar. 29, 1915	9½–9¾	October, 1919	14 –14½
June 28, 1915	11½–12½	April, 1920	15 –15½
Sept. 27, 1915	11½–12½	July, 1920	15 –15½

Lead, acetate, white, broken; prices (wholesale) per pound, New York, spot.

[Data from Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	8½– 9½	Jan. 3, 1916	11½–12½
Apr. 1, 1912	8½– 9½	Apr. 3, 1916	12½–13½
July 1, 1912	8½– 9½	July 3, 1916	14½–15½
Sept. 30, 1912	8½– 9½	Oct. 2, 1916	12½
Dec. 30, 1912	8½– 9½	Oct. 1, 1917	16½
Mar. 31, 1913	8½– 9½	Dec. 31, 1917	16½
June 30, 1913	8½– 9½	January, 1918	16½
Sept. 29, 1913	8½– 9½	April, 1918	16½–17
Dec. 29, 1913	8½– 9½	July, 1918	16½–17
Mar. 30, 1914	8½– 9	October, 1918	16½–17
June 29, 1914	8½– 9	January, 1919	15 –15½
Sept. 28, 1914	8½– 9	April, 1919	13½–14
Dec. 28, 1914	8½– 9	July, 1919	13½–14
Mar. 29, 1915	8½– 9	October, 1919	13½–14
June 28, 1915	10½–11½	April, 1920	14½–15
Sept. 27, 1915	10½–11½	July, 1920	14½ -15

Lead, acetate, brown, broken; prices (wholesale) per pound, New York, spot.

[Data from Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	7¾– 8	Jan. 3, 1916	10½–11
Apr. 1, 1912	7¾– 8	Apr. 3, 1916	11½–12
July 1, 1912	7¾– 8	July 3, 1916	13½–14
Sept. 1, 1912	7¾– 8	Oct. 2, 1916	11⅝
Dec. 30, 1912	7¾– 8	Oct. 1, 1917	15⅝
Mar. 31, 1913	7¾– 8	January, 1918	15 –15⅝
June 30, 1913	7¾– 8	April, 1918	15⅝–16
Sept. 29, 1913	7¾– 8	July, 1918	15⅝–16
Dec. 29, 1913	7¾– 8	October, 1918	15⅝–16½
Mar. 30, 1914	7¾– 7⅞	January, 1919	14½–14⅞
June 29, 1914	7¼– 7⅞	April, 1919	12⅝–13
Sept. 28, 1914	7¼– 7⅞	July, 1919	12⅝–13
Dec. 28, 1914	7¼– 7⅞	October, 1919	12⅝–13
Mar. 29, 1915	7¼– 7½	April 1920	13⅜–14
June 28, 1915	9½–10	July, 1920	13⅜–14
Sept. 27, 1915	9½–10		

Lead, nitrate; prices (wholesale), cents per pound, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan .1, 1912	8 – 8⅝	Sept. 27, 1915	11½–28
Apr. 1, 1912	8½– 8⅝	Jan. 3, 1916	13½–14
July 1, 1912	8⅝– 8⅝	Apr. 3, 1916	17 –11
Sept. 30, 1912	8¼– 8½	July 3, 1916	15½–16
Dec. 30, 1912	8 – 8⅜	Oct. 2, 1916	15½–16
Mar. 31, 1913	8⅜– 8½	Jan. 1, 1917	15½–16
June 30, 1913	8½– 8½	April, 1918	(1)
Sept. 29, 1913	8½– 8⅝	July, 1918[2]	85
Dec. 29, 1913	7⅞– 8½	October, 1918[2]	85
Mar. 30, 1914	8 – 8½	January, 1919	85 –86
June 29, 1914	8 – 8¼	April, 1919	85 –86
Sept. 28, 1914	8½	July, 1919	85 –86
Dec. 28, 1914	8	October, 1919	85 –86
Mar. 29, 1915	8	April, 1920	90 –95
June 28, 1915	11½–12	July, 1920	85 –90

Lead acetate, lead nitrate, etc.—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Acetate of lead, brown	4 cents per pound.
1883	.....	Acetate of lead, white	6 cents per pound.
1883	.....	Nitrate of lead	3 cents per pound.
1890	62	Acetate of lead, white	5½ cents per pound.
		Brown	3½ cents per pound.
1890	64	Nitrate of lead	3 cents per pound.
1894	49	Acetate of lead, white	2¾ cents per pound.
		Brown	1¾ cents per pound.
1894	50	Nitrate of lead	1¼ cents per pound.
1897	60	Lead: Acetate of, white	3½ cents per pound.
		Brown, gray, or yellow	2½ cents per pound.
		Nitrate of	2½ cents per pound.
1909	58	Lead: Acetate of, white	3 cents per pound.
		Brown, gray, or yellow	2 cents per pound.
		Nitrate of	2½ cents per pound.
1913	57	Lead: Acetate of, white, and nitrate of	1½ cents per pound.
		Acetate of, brown, gra , or yellow	1 cent per pound.
		All other lead compounds, not specially provided for in this section.	20 per cent ad valorem.

[1] Nominal. [2] Lead nitrate, C. P.

Imports of lead compounds in excess of $100 in value in fiscal year 1913–14.

[Data collected by Dr. E. R. Pickrell. Miscellaneous Series, No. 82, Department of Commerce.]

Articles.	Pounds.	Value.	Per cent of quantity by countries.
Carbonate:			
Purified	1,331	$120	Germany, 100 per cent.
C. P. neutral	96	21	Do.
Hyposulphite:			
Precipitated	3,309	80	Do.
Precipitated, pure	57,333	5,735	Do.
Linoleate	17,245	1,863	Germany, 50 per cent; England, 50 per cent.
Manganese resinate	24,128	1,999	England, 89.7 per cent; Germany, 10.3 per cent.
Nitrate	11,602	784	Scotland, 96.5 per cent; Germany, 2.6 per cent; England, 0.9 per cent.
Oleate, commercial	1,267	104	Germany, 100 per cent.
Oxide:			
Chemically pure	229	53	Do.
Reagent	458	421	Do.
Resinate:			
Fused	61,107	2,274	Belgium, 96.7 per cent; England, 3.3 per cent.
Precipitated	56,650	4,799	Germany, 100 per cent.
Sulphide, precipitated, commercial	1,854	274	England, 99.9 per cent; Germany, 0.1 per cent.
Thiocyanate, commercial	2,926	303	Germany, 100 per cent.
Acetate:			
Brown, gray, or yellow	18,301	1,001	Germany, 38.8 per cent; Belgium, 36.8 per cent; England, 14.6 per cent; Scotland, 9.8 per cent.
White	111,653	10,847	England, 37.2 per cent; Belgium, 28.9 per cent; Germany, 20.9 per cent; Austria-Hungary, 12.3 per cent; France, 0.7 per cent.

Lead compounds imported in quantities less than $100 in value: Antimonate, arsenate, borate, bromide, chloride, chromate, dioxide, ferrocyanide, fluoride, hydroxide, iodide, lactate, manganate, ointment (?), oxalate, peroxide, phosphate, pulverized (?), resoleate, sesquioxide, silicate, silicofluoride, stearate, subacetartrate, subacetate, suboxide, sulphate, tannate, tartrate, telluride, tetra ethyl, tungstate, and vanadate.

VARNISHES.

[Par. 58, act of 1913.]

Summary table.

Year.	Domestic production (calendar years).	Imports for consumption (fiscal years).	Domestic exports (fiscal years).	Ratio to production.	
				Imports.	Exports.
				Per cent.	*Per cent.*
1910	[1] $31,262,535	$65,522	$976,238	0.21	3.1
1911		61,975	1,050,290		
1912		65,679	1,118,004		
1913		55,787	1,267,860		
1914	33,214,949	64,066	1,038,884	.19	3.1
1915		63,956	682,352		
1916		70,073	838,339		
1917		63,669	1,104,698		
1918		28,597	1,209,762		
1919		23,238			

[1] 1909.

TOTAL OF ALL VARNISHES IMPORTED.

Year.	Value (imports for consumption).	Amount of duty.	Equivalent ad valorem rate.	Year.	Value (imports for consumption).	Amount of duty.	Equivalent ad valorem rate.
			Per cent.				*Per cent.*
1910	$65,522	$27,053	41.3	1915	$63,956	$6,869	10.7
1911	61,975	19,443	31.4	1916	70,073	7,240	10.3
1912	65,679	20,209	30.8	1917	63,669	6,768	10.6
1913	55,787	15,547	27.9	1918	28,597	4,048	14.2
1914	64,066	9,320	14.5	1919	23,238	1,111	4.8

General Information.

DESCRIPTION AND USES.

Act of 1913: "58. Varnishes, including so-called gold size or japan, 10 per cent ad valorem: *Provided*, That spirit varnishes containing less than 10 per cent of methyl alcohol of the total alcohol contained therein, shall be dutiable at $1.32 per gallon and 15 per cent ad valorem."

A varnish may be defined as a homogeneous liquid, which when applied in a thin layer over a surface dries either by the evaporation of the volatile solvent or by the combined evaporation of the solvent and the oxidation of the oil and resins to a more or less impervious elastic film. Varnishes according to this definition may be divided into two classes—(1) spirit varnishes, which are a solution of a resin or other suitable material in a volatile solvent; (2) oil or oleo-resinous varnishes, which contain a resin, a drying oil (usually linseed or Chinese nut), a thinner, and a drier.

1. Spirit varnishes: Amber, asphaltum, caoutchouc, pyroxylin (nitrocellulose), dammar, gutta percha, mastic, rosin (gloss oil), sandarac, and shell lac.

2. Oil varnishes: Antifouling, asphaltum, black (from coal tar), caoutchouc, copal, dammar, gold size, japan, polychrome, rosin, rosinate, and stearin.

According to the classification above pyroxylin varnishes are included under spirit varnishes. As they are entirely different in chemical composition they might logically constitute a third class of varnishes, thus limiting spirit varnishes to those consisting of a solution of a resin in a volatile solvent.

Of the different classes of varnishes the oil varnishes constitute the largest and most important group. The most important spirit varnish is "shellac," which is a solution of shell lac resin in denatured or wood alcohol. Other spirit varnishes consist of mastic, sandarac or dammar resins dissolved usually in spirits of turpentine or methyl and amyl alcohol.

Varnishes in the drying of which heat is applied in a closed compartment so as to expel the solvents through suitable outlets and then fuse the residual layer of resin so that it is uniform like glass are termed "japans," "baking-japans," or "baking-varnishes." Another class of japans entirely different from the above are "japan driers," which are thin liquids consisting of linoleates or resinates of various metals (lead and manganese) usually containing an oil, often some resinous varnish, and a solvent, turpentine or more often benzine.

Gold size is a varnish used in preparing surfaces on which gold leaf is to be applied. *Lacquer* is a highly transparent varnish used to produce a thin protective film on metals to preserve their luster. Some of the lacquers are finished by heating and others by merely drying in the air. The term is used somewhat interchangeably in the trade with japans. They should not be confused with Japanese lacquer, which is a natural varnish obtained as a milky juice by wounding a tree—Rhus Vernicifera—indigenous to Japan. It is used locally and does not enter international commerce to any extent.

Spar varnishes are so called because designed to be used for varnishing masts and spars of ships. The term is now more widely used

to include varnishes made to withstand weather conditions and water-proof varnishes. These varnishes are an oil varnish, now usually made from rosin and Chinese nut oil. "Marine" is usually a cheaper grade of spar varnish. "Hard-oil finish" is or should be a hard drying and rather cheap rosin varnish for interior house finishing and is considerably inferior to the standard inside varnishes. "Coach" is a cheap rosin varnish but is never used in coach painting as might be inferred. "Gloss oil" is a solution of rosin in benzine and is about the poorest varnish made.

In varnish nomemclature the unit of 100 pounds of resin is the basis. Varnishes are described as containing so many gallons of oil to this 100 pounds of resin, weighed before melting. Since from 10 to 25 per cent of the resin is volatilized in the varnish kettle, this basis has no reference to the composition of the finished product as marketed. Thus a 20-gallon kauri is a varnish made from 100 pounds of kauri copal and 20 gallons of linseed oil and an unstated quantity (usually 30 gallons) of spirits of turpentine.

Varnishes are also classified as "long" or "short" which refers to the relative proportion of oil in the varnish. Long varnishes contain more oil than short ones. This is a variable division, but generally a varnish containing 20 gallons or more of oil is "long" and 12 gallons or less is "short." The most important short varnishes are rubbing and furniture varnishes and of the long the spar and wearing body are the most important.

DOMESTIC PRODUCTION.

Size of the industry.—The varnish industry of the United States is larger than that of any other country. This is evidenced by the quantity of varnish resins exported from foreign countries to the United States compared with the quantities going to other countries. Nearly 50 per cent of the lac from India, of kauri from New Zealand, and of copal and dammar from the Dutch East Indies and the Straits Settlements reaches the United States. This large consumption of gum resins used for varnish making indicates that the Unuted States possesses an industry not equaled by any foreign country.

In 1914 there were 215 establishments engaged primarily in the manufacture of varnishes with an output of finished products valued at $33,214,949. The capitalization of the industry in 1914 was $29,860,798. The total number of persons engaged in the industry was 5,610.

Raw materials.—The principal materials entering into the manufacture of varnishes are resins (shell-lac, copals, dammars, kauri, rosin), volatile sovents, such as turpentine, wood alcohol and denatured alcohol, and drying oils, principally linseed and Chinese nut oils. Of these materials the resins are obtained by importation from foreign countries, chiefly India, East and West Africa, Dutch East Indies, the Straits Settlements, and New Zealand. Chinese nut oil, an important ingredient of water-proof varnishes, is obtained from China and Japan. The other materials are produced from domestic sources in sufficient quantity to supply the requirements of the industry.

Recently synthetic resins manufactured from coal-tar distillates have been introduced for use in the manufacture of varnishes. It is claimed these resins are cheaper than the better grades of resins

imported. The future development of these synthetic resins will reduce the dependence of the varnish industry on imported resins.[1]

Domestic output.—The output of varnishes in 1914 by those firms engaged primarily in the manufacture of varnishes was $33,214,949. In addition products produced by firms in other industries brought the total up to $36,142,256 in 1914. This is only a slight gain over the 1909 production. Of the 1914 output over 50 per cent is accounted for by oleoresinous (oil) varnishes. The other classes in order of value were "spirit varnishes not turpentine," "drying japans and dryers," damar and similar turpentine and benzine," and "pyroxylin."

The State of New York produced about 28 per cent of the total in 1914, or $9,500,000. New Jersey, Illinois, and Ohio were next in order of output with the production of each valued at approximately $5,000,000. Pennsylvania and Massachusetts each produced varnish valued at about $1,500,000. It is seen that about 50 per cent of the varnish is produced in the vicinity of New York City.

The domestic production supplies more than 99 per cent of the demand in the United States as imports in 1909 and in 1914 were only 0.2 per cent of the domestic output (basis of value).

Domestic exports.—From 1910 to 1914, inclusive, the exports of varnish were valued at approximately $1,000,000 annually. The United Kingdom during this period was the chief consumer and took about 25 per cent of the total export. The other principal consuming countries were Germany, Canada, Mexico, and France. During 1915 and 1916 the exports decreased slightly and in 1917 and 1918 they were a little over $1,000,000 in value. In 1918 the principal countries of destination of the exports were Canada, Argentina, and Cuba in the order given, these countries taking about one-third of the total. The exports of varnish are diversified, no one country predominating to any marked extent.

Exports in 1909 and 1914 were about 3 per cent of the domestic production (basis of value).

IMPORTS INTO THE UNITED STATES.

The total imports of all varnishes during the period 1910 to 1917 have been fairly uniform, ranging from $55,787 in 1913 to $70,073 in 1916. The imports decreased to $23,238 in 1919. In 1914 imports amounted to only 0.2 per cent of the domestic production (based on value). Imports have been chiefly of the "all other" class dutiable at 25 per cent and 10 per cent ad valorem under the acts of 1909 and 1913, respectively. The imports of spirit varnish and gold size and japan have been small and sporadic.

The revenue collected on all varnishes has been small. From 1910 to 1913 the maximum was $27,053 in 1910. From 1915 to 1919 the revenue collected ranged from $1,111 in 1919 to $7,240 in 1916. The equivalent ad valorem on all varnishes has followed closely the duty on "all other varnishes," as this class constitutes the bulk of imports.

[1] These resins introduced by the Barrett Co., of New York, under the trade name of "Cumar." See Jr. of Ind. and Eng. Chem., June, 1920, p. 547.

TARIFF HISTORY AND CONSIDERATIONS.

Varnishes, with the exception of gold size under the act of 1883, have been dutiable. The duty on spirit varnishes has uniformly been higher than the duty on other varnishes. In the act of 1890 the phrase "varnishes, including so-called gold size or japan," was adopted and has remained unchanged in each succeeding tariff act. The duty on this group has been 35 per cent under the acts of 1890 and 1897, 25 per cent under the acts of 1894 and 1909, and 10 per cent under the act of 1913. The duty on spirit varnishes under the acts of 1883 to 1897 was $1.32 per gallon in addition to the duty on varnishes, with the exception of the acts of 1890 and 1894, when this additional duty applied only to the alcohol contained in spirit varnishes. In the act of 1909 the duty on "spirit varnish containing 5 per cent or more of methyl alcohol" was 35 cents per gallon and 35 per cent ad valorem, while on spirit varnish containing less than 5 per cent of methyl alcohol the duty was $1.32 per gallon and 35 per cent ad valorem. The act of 1913 provided that a duty of $1.32 per gallon and 15 per cent ad valorem should be levied on all spirit varnishes containing less than 10 per cent of methyl alcohol of the alcohol contained therein. Spirit varnishes containing more than this quantity of methyl alcohol not being provided for became dutiable at the rate for varnishes (10 per cent ad valorem).

There is no special tariff problem connected with the varnish industry other than the proper division between spirit varnishes made from grain alcohol and those made from denatured alcohol. The former must pay an internal-revenue tax on the grain alcohol used while denatured alcohol is exempt from internal-revenue tax. In order to offset this internal-revenue tax on grain alcohol a higher rate of duty has been levied in all tariff acts on varnishes made from grain alcohol. At the present time the difference in duty is 5 per cent ad valorem plus $1.32 per gallon, and the division between those made from grain alcohol and denatured alcohol is placed at 10 per cent of methyl alcohol of the total alcohol content.

This division of spirit varnishes at the time of the passage of the act of 1913 was in accordance with denaturing formulæ then in use in the United States. Since then the quantity of wood alcohol (methanol) to be added to 100 gallons of grain alcohol (190 proof) has been reduced from 10 gallons to 5 gallons. In other words at the present time denatured alcohol[1] for spirit varnish manufacture contains somewhat less than 5 per cent by volume of wood alcohol. The present division between spirit varnishes should logically be reduced to 5 per cent of wood alcohol to correspond to the present denaturing formula.

Since the passage of the act of 1913 the internal-revenue tax on grain alcohol for other than beverage purposes has been increased from $1.10 to $2.20 per proof gallon.[2] This corresponds to a tax of about $4.20 per gallon, as the grain alcohol used in spirit varnishes is between 188 and 190 proof. In the act of 1913 spirit varnishes made from grain alcohol are assessed a duty of 5 per cent plus $1.32 per gallon more than those made from denatured alcohol. As the

[1] See formula No. 1, Regulations No. 61, U. S. Internal Revenue.
[2] Revenue act of Oct. 3, 1917. A proof gallon or 100 proof is alcohol containing 50 per cent of absolute ethyl alcohol.

internal-revenue tax on grain alcohol has been doubled since the passage of the act of 1913, it is evident that the duty on this class of spirit varnishes should be adjusted so as to compensate for this increase.

Statistics of the varnish industry.

[From Census of Manufactures, Department of Commerce.]

	1914	1909	1904	1899
Number of establishments	215	203	190	181
Cost of materials	$16,877,393	$16,557,305	$13,520,491	$10,939,131
Total value of products	$33,214,949	$30,317,417	$23,561,699	$18,687,240
PRODUCTS PRODUCED BY VARNISH INDUSTRY.				
Oleoresinous varnishes:				
Gallons	17,801,438	18,692,527	17,323,719	14,804,251
Value	$18,762,399	$17,559,898	$15,704,237	$14,530,159
Spirit varnishes (not turpentine):				
Gallons	2,964,172	1,273,411	1,540,362	553,432
Value	$3,080,425	$1,502,398	$2,199,213	$921,169
Damar and similar turpentine and benzine varnish:				
Gallons	3,297,371	3,483,994	.....	.....
Value	$2,865,256	$2,839,534	.....	.....
Pyroxylin varnishes:				
Gallons	852,571	1,886,541	452,561	171,129
Value	$1,308,796	$2,356,692	$555,959	$187,626
Drying japans and dryers:				
Gallons	6,560,406	6,638,706	4,357,505	6,564,370
Value	$3,015,907	$3,165,589	$3,349,000	$3,085,954
Baking japans and lacquer:				
Gallons	4,888,816	2,983,285	.....	.....
Value	$2,960,856	$2,079,927	.....	.....
All other	$4,148,617	$2,254,697	.....	.....

Varnishes and japans—Production in United States—States.

[From "Federal Census."]

State.	1909	1914	State.	1909	1914
New York	$7,639,299	$9,458,463	Massachusetts	$807,970	$1,543,958
New Jersey	5,009,691	5,233,475	All other	7,853,258	5,233,349
Illinois	4,495,602	5,445,680			
Ohio	3,642,164	4,502,503	Total	31,262,535	33,214,949
Pennsylvania	1,814,551	1,797,521			

Spirit varnish, containing less than 10 per cent methyl alcohol—Imports for consumption—Revenue.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Gallons.				*Per cent.*
1910	$1.32 per gallon and 35 per cent ad valorem.	5,340	$6,103	$9,185	$1.14	150.51
1911	....do....	430	1,652	1,147	3.84	69.41
1912	....do....	269	903	672	3.35	74.43
1913	....do....	698	2,183	1,685	3.13	77.23
1914[2]	....do....	111	417	293	3.73	70.41
1914[3]	$1.32 per gallon and 15 per cent ad valorem.	330	1,939	727	5.86	37.49
1915	....do....	313	1,251	600	4.00	48.02
1916	....do....	145	853	319	5.88	37.44
1917	....do....	228	2,030	605	8.90	29.83
1918	....do....	869	870	1,277	1.00	146.85
1919	....do....	36	673	148	18.70	21.99

[1] Prior to Oct. 3, 1913, under the act of 1909, "containing less than 5 per cent of methyl alcohol."
[2] From July 1 to Oct. 3, 1913.
[3] From Oct. 4, 1913, to June 30, 1914.

Spirit varnish, containing 10 per cent or more of methyl alcohol—Imports for consumption—Revenue.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Gallons.				*Per cent.*
1910	35 cents per gallon and 35 per cent ad valorem.	4,919	$5,900	$3,786	$1.20	64.18
1911	do	6,889	8,039	5,225	1.18	65.00
1912	do	5,002	15,924	7,324	3.18	45.99
1913	do	776	1,894	935	2.44	49.34
1914 [2]	do	309	961	444	3.10	46.28
1914 [3]	10 per cent ad valorem.	9,374	21,012	2,101	2.24	10.00
1915	do	268	686	68	2.56	10.00
1916	do	1,173	6,021	602	5.13	10.00
1917	do	2,543	11,395	1,139	4.48	10.00
1918	do	417	2,163	216	5.19	10.00
1919	do	1	3			

[1] Prior to Oct. 3, 1913, under the act of 1909, "containing 5 per cent or more of methyl alcohol.
[2] From July to Oct. 3, 1913.
[3] From Oct. 4, 1913, to June 30, 1914.

Gold size or japan—Imports for consumption—Revenue.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Gallons.				*Per cent.*
1914 [2]	10 per cent ad valorem.	([3])	$8,705	$870		10.00
1915	do	([3])	10,228	1,022		10.00
1916	do	([3])	423	42		10.00
1917	do	([3])	2,504	250		10.00
1918	do	([3])	1,217	121		10.00
1919	do	2,005	8,192	819	$4.08	10.00

[1] Included in all other varnishes prior to Oct. 3, 1913.
[2] From Oct. 4, 1913, to June 30, 1914.
[3] Not given prior to 1919.

All other varnishes—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Gallons.				*Per cent.*
1910 [1]	35 per cent ad valorem.	3,599	$7,028	$2,460	$1.95	35
1910 [2]	25 per cent ad valorem.	24,080	46,491	11,622	1.93	25
1911	do	28,641	52,284	13,071	1.83	25
1912	do	24,312	48,852	12,213	2.01	25
1913	do	25,092	51,710	12,927	2.06	25
1914 [3]	do	5,947	11,881	2,970	2.00	25
1914 [4]	10 per cent ad valorem.	9,940	19,151	1,915	1.93	10
1915	do	27,943	51,791	5,179	1.85	10
1916	do	25,542	62,776	6,277	2.46	10
1917	do	20,366	47,740	4,774	2.34	10
1918	do	10,923	24,347	2,434	2.23	10
1919	do	4,256	14,370	144	3.38	10

[1] From July to Aug. 5, 1909.
[2] From Aug. 6, 1909, to June 30, 1910.
[3] From July 1 to Oct. 3, 1913.
[4] From Oct. 4, 1913, to June 30, 1914.

Varnishes—Domestic exports.

[Fiscal years.]

Exported to—	1910		1911		1912	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
Austria-Hungary	9,842	$17,182	10,036	$17,042	15,613	$23,890
Belgium	26,906	19,779	32,139	23,078	27,617	24,152
France	55,457	52,995	62,195	77,619	46,889	58,612
Germany	133,535	124,047	130,200	116,270	149,646	129,548
Italy	20,546	20,752	29,404	28,045	28,077	24,189
Netherlands	7,623	16,909	9,479	18,219	9,932	19,943
Russia	2,967	6,263	4,906	6,411	15,689	19,936
Spain	7,602	6,973	7,157	6,353	10,516	9,754
United Kingdom	375,064	245,184	349,086	242,787	357,783	252,333
Sweden	19,657	21,401	32,724	37,495	25,739	27,344
Canada	55,954	89,584	48,323	74,029	53,363	75,591
Mexico	58,884	66,436	72,146	73,634	51,729	61,896
Cuba	48,640	44,174	51,378	41,986	51,141	44,913
Argentina	26,430	43,362	20,548	31,271	28,958	50,814
Brazil	13,433	18,274	15,145	21,494	24,576	40,166
Chile	8,015	8,453	11,282	11,635	26,321	30,551
Japan	19,233	22,933	37,622	44,071	22,884	20,532
Australia	17,725	27,019	39,563	55,916	57,577	76,309
New Zealand	11,661	15,221	9,822	13,043	15,996	21,220
Philippines	27,082	27,514	20,495	21,488	15,115	16,664
Total	1,017,284	976,238	1,074,264	1,050,290	1,114,413	1,118,004

Exported to—	1913		1914		1915	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
Austria-Hungary	17,245	$18,559	18,701	$18,944	1,311	$1,501
Belgium	37,071	34,208	29,453	30,488	3,393	3,948
France	58,709	59,844	73,291	76,334	9,587	7,977
Germany	137,401	111,147	122,722	97,766	8,734	7,032
Italy	44,602	37,613	43,932	38,208	48,432	40,682
Netherlands	14,280	26,343	13,947	23,895	12,304	16,390
Russia	25,239	36,081	20,010	25,003	484	1,286
Spain	15,665	13,225	13,228	13,178	13,319	11,380
United Kingdom	403,204	266,618	333,388	208,866	287,233	177,188
Sweden	41,789	45,086	42,951	49,888	43,748	45,810
Canada	38,558	55,055	35,346	55,262	29,158	41,469
Mexico	54,184	68,605	22,543	32,370	12,609	17,617
Cuba	61,256	53,932	48,611	48,748	47,586	41,974
Argentina	36,940	56,250	14,912	22,253	21,125	30,017
Brazil	41,795	81,809	17,509	30,057	17,465	26,646
Chile	8,845	9,768	7,364	10,712	2,612	2,017
Japan	39,867	37,158	29,541	28,285	21,361	22,136
Australia	51,837	75,902	48,675	71,000	38,648	57,506
New Zealand	19,996	25,848	16,304	19,897	9,788	12,300
Phillipines	36,805	33,846	22,750	21,420	19,233	19,933
Total	1,279,777	1,267,860	1,069,501	1,088,864	731,604	682,352

Exported to—	1916		1917		1918	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
France	32,777	$21,256	62,947	$51,976	44,789	$37,492
Italy	51,276	46,052	65,720	67,511	15,704	40,800
Netherlands	11,282	19,415	6,945	14,041	.....	.....
Russia	8,113	8,976	10	4	5,903	7,800
Spain	18,325	20,081	9,819	18,378	13,947	20,513
United Kingdom	242,483	151,618	119,086	96,148	21,736	25,894
Sweden	66,750	69,007	75,765	101,104	8,780	11,689
Canada	33,320	73,916	34,252	71,686	90,230	263,002
Mexico	15,781	19,079	25,528	38,363	26,546	44,675
Cuba	73,589	64,840	66,141	77,047	89,153	113,962
Argentina	23,334	32,943	33,202	55,902	71,346	124,640
Brazil	38,309	64,652	48,366	82,738	38,783	71,598
Chile	6,032	6,261	14,802	23,520	37,714	52,439
Japan	33,613	33,265	85,090	103,913	52,965	71,705
Australia	29,365	43,319	21,661	37,362	19,664	30,553
New Zealand	11,867	13,775	15,906	20,377	14,270	18,134
Philippines	17,071	15,940	36,411	31,935	38,517	53,398
Total	846,362	838,339	891,812	1,104,698	736,949	1,209,762

Varnishes—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad ad valorem.
1883	119	Varnishes of all kinds	40 per cent ad valorem.
		And on spirit varnishes	$1.32 additional per gallon.
1883	711	Gold size	Free.
1890	56	Varnishes, including so-called gold size or japan	35 per cent ad valorem.
		And on spirit varnishes for the alcohol contained therein	$1.32 per gallon additional.
1894	44	Varnishes, including so-called gold size or japan	25 per cent ad valorem.
		And on spirit varnishes for the alcohol contained therein	$1.32 per gallon additional.
1897	53	Varnishes, including so-called gold size or japan	35 per cent ad valorem.
		Spirit varnishes	$1.32 per gallon and 35 per cent ad valorem.
1909	51	Varnishes, including so-called gold size or japan	25 per cent ad valorem.
		* * * spirit varnish containing 5 per centum or more of methyl alcohol.	35 cents per gallon and 35 per cent ad valorem.
1909	51	Spirit varnish containing less than 5 per centum of methyl alcohol	$1.32 per gallon and 35 per cent ad valorem.
1913	58	Varnishes, including so-called gold size or japan	10 per cent ad valorem.
		Provided, That spirit varnishes containing less than 10 per centum of methyl alcohol of the total alcohol contained therein shall be dutiable at.	$1.32 per gallon and 15 per cent ad valorem.

Court and Treasury Decisions.

The word "spirit" as used in paragraph 56 of the act of 1890 was interpreted to embrace "all inflammable liquors obtained by distillation, and especially alcohol." (G. A. 688, T. D. 11405.)

Enamel paint consisting of a white paint containing zinc but not containing lead and ground in linseed oil, varnish being added to give a gloss but without affecting the character of the mixture as a paint, was held more specifically enumerated in the provision in paragraph 57 of the act of 1897 for "white paint or pigment containing zinc, but not containing lead" than under the provision in paragraph 53 for "varnishes" or the provision in paragraph 58 for "all paints * * * whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for." (*Pomeroy* v. *United States*, 126 Fed., 583; *United States* v. *Bird*, 167 Fed., 319.)

Roller varnish.—A physical solution of gelatin with acetic acid, water, and coloring matter, the gelatin being the component material of chief value and still possessing its natural inherent qualities, known as "Red Top roller varnish" or "roller varnish," used to dress the surfaces of leather rollers in woolen mills, is not a varnish within paragraph 58 of the act of 1913 nor a nonenumerated manufacture under paragraph 385, but dutiable as a manufacture of gelatin under paragraph 34. (*United States* v. *Vandegrift*, 9 Ct. Cust. Appls., 30; T. D. 37874, of 1918.)

No duty for the alcohol is levied in the 1913 act upon spirit varnishes containing 10 per cent or more of methyl alcohol of the total alcohol contained therein. Importations containing slightly more

than 10 per cent of methyl alcohol of the total alcohol would accordingly be dutiable at 10 per cent ad valorem only, whereas importations containing slightly less than 10 per cent of methyl alcohol of the total alcohol would be dutiable at $1.32 per gallon and 15 per cent ad valorem. Another matter for consideration is whether the specific rate of $1.32 per gallon is sufficiently compensatory in view of the increased tax on distilled spirits.

In holding a solution of gum shellac or lac and methylated spirits, in the proportion of about 80 per cent of the latter and 20 per cent of the former, and known commercially as spirit varnish, not to be exempt from duty as lac spirits under paragraph 547 of the act of 1890, the Board of General Appraisers said: (G. A. 1504, T. D. 12953.)

Lac spirits appeared for the first time in the free list of our tariff in juxtaposition with lac dye in the act of March 2, 1861, and the two articles have been so associated together in all subsequent tariff acts, in all of which acts (including that of Mar. 2, 1891) high rates of duty have been imposed on all alcoholic spirits, whether distilled from grain or produced from other materials, and excise taxes have also been steadily maintained thereon. The purpose of Congress to carefully safeguard this system of customs and internal-revenue taxation is made abundantly manifest by the imposition of very high rates of duty upon all compounds, preparations, etc., containing distilled spirits, including various articles in the preparation of which distilled spirits are used, even though such articles, in the condition as imported, do not actually contain any of the spirits so used.

Merchandise invoiced as "ruby varnish" and classified as a spirit varnish under paragraph 53 of the act of 1897 was found to be commercially known as ruby varnish and to consist of a colored solution of acetyl cellulose in acetone, with no alcohol and to be dutiable at the 35 per cent rate imposed in paragraph 53 of the act of 1897 on varnish and not at the compound rates of $1.32 per gallon and 35 per cent ad valorem as spirit varnish. (Abstract 1901, T. D. 25385; Abstract 3032, T. D. 25665.)

As gold size and japan are distinct articles, they would be better connected by the conjunction "and" instead of "or."

A solution of a cellulose ester somewhat similar to the pyroxylin varnishes described above was held to be dutiable as a compound of cellulose esters.

See survey on "Shellac and other lac."

VERMILION REDS.

Summary.

Quicksilver vermilion is one of the oldest known pigments. It is bright red, permanent, opaque, and brilliant, and is much used in fresco and tempera painting. It is so expensive, however, that substitutes, chiefly lead compounds or lakes stained with organic dyes, are used instead of the genuine quicksilver compound whenever possible. The most important substitutes are chrome red (lead chromate), which is known in the trade as "American vermilion," and eosine vermilion, also known as "vermilionette," which is composed of orange mineral (a form of red lead) stained with eosine. Both these compounds can be considered as vermilion reds "not containing quicksilver but made of lead or containing lead" and therefore coming within the meaning of paragraph 59 of the tariff act of 1913.

The former, however, may also be considered as coming under the designation of paragraph 54 as a chromium color "in the manufacture of which lead and bichromate of potash or soda are used" (under this provision, however, it would be dutiable at only 20 per cent instead of 25 per cent as a vermilion). Eosine vermilion is a lake and as such is dutiable (1916) at 5 cents per pound plus 30 per cent ad valorem.

The important constituent of true vermilion is the quicksilver. The process of manufacture is not particularly difficult or expensive, although it does require a certain degree of skill. The quicksilver content of vermilion is slightly more than 86 per cent and the cost of the metal constitutes fully 90 per cent of the selling price of the pigment. The price of the metal is considerably higher in this country than in most foreign countries. The production of the pigment, therefore, must be considered in its connection with the cost of the metal.

The total domestic output of quicksilver vermilion in 1914 was 322,759 pounds, valued at $200,134. Imports, prior to the war, averaged about 75,000 pounds, annually and were derived chiefly from Germany and Great Britain.

Vermilion, containing quicksilver—Summary table.

Calendar year.	Domestic production.	Imports for consumption.	Ratio of imports to production.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent or actual ad valorem rate.
	Pounds.	*Pounds.*	*Per cent.*				*Per cent.*
1911	.....	89,873	.....	$50,360	$8,987.33	$0.563	17.8
1912	.....	84,546	.....	45,833	8,454.60	.541	18.5
1913	.....	71,465	.....	36,012	6,370.90	.503	17.7
1914	322,759	78,050	24.3	37,755	5,663.25	.484	15.0
1915	.....	70,622	.....	57,849	8,677.35	.818	15.0
1916	.....	58,535	.....	79,411	11,911.65	1.354	15.0
1917	[1] 200,000	16,751	8.4	24,441	3,666.15	1.459	15.0
1918	.....	2,368	.....	3,134	470.10	1.323	15.0

[1] Estimated.

General Information.

[Par. 59, act of 1913.]

"Vermilion reds, containing quicksilver, dry or ground in oil or water, 15 per centum ad valorem; when not containing quicksilver but made of lead or containing lead, 25 per centum ad valorem."

DESCRIPTION.

Vermilion red is ordinarily understood to mean the red sulphide of mercury suitable for use as pigment. In the trade, however, vermilion containing quicksilver or genuine vermilion is distinguished from "American vermilion" or vermilion containing lead but not containing quicksilver and corresponding in composition to chrome red (chromate of lead). Another so-called vermilion is eosine vermilion, which is more often referred to as "vermilionette"

and is really a color lake composed of a base that has been enhanced in color by the addition of eosine, a coal-tar dye.[1]

Quicksilver vermilion.—True vermilion may be either of natural or artificial origin. The natural red sulphide of mercury is one of the oldest pigments known and was undoubtedly used by the ancient Hebrews, the Assyrians, and still earlier by the Chinese. While the natural sulphide (cinnabar) is still mined on a considerable scale as a source of metallic mercury, it is not largely used as a pigment. A small amount comes on the market as "Trieste vermilion" which is mined in Austria and has always been regarded as the most permanent of the quicksilver colors. Most of the quicksilver vermilion that is used at the present time is manufactured. It has a much brighter shade than the native variety. The market names are English vermilion (or American quicksilver vermilion) and Chinese vermilion. The latter is the highest quality and is much more expensive than any of the various grades of the former.

Quicksilver vermilion was formerly used wherever a permanent red was desired. This color was the only red that could be used for railroad work, as it does not change its color when exposed to sulphur (coal) gases as do the lead colors. But while it resists the action of sulphur, vermilion eventually darkens after long exposure to light [2] although it is generally looked upon as a comparatively stable pigment. It is very heavy, opaque, and brilliant; but it is difficult to apply evenly as it is so heavy that it settles out of the oil when mixed as paint. It can not be used as a water color. It is much used in fresco work and tempera painting; but according to Toch [3] mixed paint manufacturers do not use it because the so-called para-ni-traniline reds are better, cheaper, and more permanent.

Since it is a costly pigment, vermilion is frequently adulterated. The most frequent adulterants are red lead (minium), red ochre, red oxide of iron, and even gypsum. The color is sometimes strengthened by dragon's blood or other organic coloring matter. Chinese vermilion generally contains a small amount of glue; but this can not be considered an adulteration.

Other mercury colors.—Antifouling and ship's bottom paint is a comparatively recent development in the use of quicksilver in the paint industry. These paints as now prepared for the United States Navy and other consumers contains mercuric oxide as the active poison [4] together with various pigments and vehicles. While the quicksilver in this compound is not a pigment, it may be noted that the domestic consumption of the metal for antifouling paints

[1] The name vermilion is also applied to the cochineal insect and it also appears in the description of a great number of organic colors and dyes being loosely applied referring to a scarlet color resembling the red modification of mercuric sulphide. Antimony vermilion is one of the names for antimony red (oxysulphide of antimony) which was formerly used to some extent as a pigment but which is now practically obsolete.

[2] This change is due to the gradual transformation into black form of the sulphide.

[3] Chemistry and Technology of Paints. Van Nostrand. 1916.

[4] The action of salt water results in the slow transformation of the mercury oxide (HgO) into the poisonous chloride (corrosive sublimate, $HgCl_2$) that kills the barnacles and seaweed which then drop off. According to Toch (loc. cit.) the composition of the U. S. Navy antifouling paint is as follows:

6½ gallons shellac varnish, 15 pounds zinc oxide;
4 gallons denatured alcohol, 5 pounds blanc fixe;
2½ gallons pine tar, 25 pounds indian red;
2½ gallons turpentine, 10 pounds red oxide of mercury.
15 gallons (yield).

is practically equal to that used for vermilion and is likely to soon exceed it.[1]

Brilliant scarlet (royal scarlet, pure scarlet, etc.) is the iodide of mercury (HgI_2). This is an extremely brilliant pigment, has good body, and for some time was heralded as a valuable color. It has proved fugitive in oil, worthless for water-color work, and far too costly for any practical use.

Chromates of mercury (both $HgCrO_4$ and Hg_2CrO_4) are fine, attractive red colors but they are practically valueless as pigments.

Chrome red.—Basic lead chromate, $PbCrO_4$. PbO or $Pb_2CrO_4(OH)_2$, can be prepared as an orange-scarlet pigment which is sold as chrome red, Austrian cinnabar, American vermilion, Chinese red, etc. The tariff description is "vermilion reds not containing quicksilver but containing lead." This description, however, is not quite definite as it might also include eosine vermilion which, as stated above, is essentially an oxide of lead toned up with a small amount of coal-tar dye. Chrome red can strictly be considered as a chrome color since it is made from lead and bichromate of potash or soda and, as such, should come under the designation of paragraph 54 of the tariff act of 1913. The latter, however, is dutiable at only 20 per cent ad valorem whereas the description "Vermilion red" when applied to an article of the same composition makes it dutiable at 25 per cent ad valorem.

Chrome red is a fairly bright red, of good body, working well in oil. In common with all lead pigments it is darkened by sulphur and hydrogen sulphide (in coal gas). Its properties and manufacture have been discussed in the Tariff Information Survey on Chrome Colors which should be consulted for further information in regard to this article.

DOMESTIC PRODUCTION.

The production of vermilion reds is one of the minor branches of the paint industry. The total output in 1914 as reported by the United States Census was only 322,759 pounds, valued at $200,134.

Raw materials.—The essential components of true vermilion red are quicksilver and sulphur. The important constituent is the quicksilver, which is an article of prime necessity for military and other industrial purposes. While the United States has been one of the large producers of this metal, the cost of quicksilver in the future is likely to be much greater in this country than abroad, and upon it will depend the extent of the handicap of the domestic manufacturer of vermilion as regards the cost of his chief raw material.

Domestic manufacturers of vermilion are at no disadvantage as regards their supply of sulphur in any of the forms requisite for the manufacture of their product.

Processes of manufacture.—True vermilion is generally prepared from its elements, mercury and sulphur, which are first caused to unite to form a black mass called "ethiops,"[2] which is chiefly amorphous black sulphide of mercury (HgS) with some free sulphur. The

[1] As the mercury paints seem to be rapidly displacing other preparations for the preservation of ship's bottoms, its use promises to greatly increase. The consumptions of quicksilver in 1917, as reported by the Geological Survey (Min. Res. 1917. Pt. I, p. 384), were 3130 flasks of 75 pounds each for the manufacture of vermilion and 3,000 flasks for the manufacture of antifouling paint. Each gallon of this paint contains about three-fourths pound of quicksilver and will cover about 243 feet of surface.

[2] Cf. the Ethiops Mineralis of pharmacy.

molecular change from this black compound to the scarlet product may be effected in two ways (1) by the wet or (2) by the dry process.

The wet process is used for the production of English vermilion. The process is started by grinding sulphur (38 parts) and mercury (100 parts) together until they are thoroughly incorporated. The mass is then digested (at about 45° C.) with a solution of caustic potash (25 parts in 150 parts of water). The mixture is stirred frequently and water lost by evaporation is replaced. After two or three hours, the mass turns brown and then gradually becomes red. The desired color is obtained in about eight hours, and as soon as it is attained the pigment must be washed at once, since further action of the potash dulls the color. The pigment is ground and dried carefully, as any overheating (above 40° or 45° C.) causes it to turn brown. Potassium or sodium polysulphide may be used instead of potash, and the brilliancy of the color is sometimes improved by treatment with hydrochloric or nitric acid.

The dry process yields the best product but requires a little more skill in the operation. In the Dutch process the ethiops is prepared by heating the mercury and sulphur together in iron pans until they combine. The black sulphide is then pulverized and introduced into earthenware retorts in small amounts at a time. The larger part of the black sulphide sublimes as a bright red powder in the upper part of the retort. It is ground, washed, treated with acid, levigated, and dried. The Chinese process is now known to be quite similar to the Dutch method and the unusually fine quality of the product is due to the patience and care exercised by the Chinese rather than to any peculiarities in their process.

Domestic production and consumption.—The annual domestic consumption of quicksilver for the preparation of vermilion was estimated in 1917 as 3,130 flasks, which is equivalent to only a little more than 200,000 pounds of vermilion. The normal consumption is probably more nearly represented by the prewar figures. The prices at that time were somewhat less than one-third those that prevailed in 1917–18. It may be assumed, therefore, that the annual consumption in this country is between 350,000 and 400,000 pounds, of which some 80 per cent is produced in the United States.

Domestic exports.—Exports of vermilion red are not reported separately and may be considered unimportant.

FOREIGN PRODUCTION.

Vermilion is manufactured in various European countries of which Germany and Great Britain have been the most important. These countries get a relatively cheap supply of quicksilver from deposits in Spain, Austria, and Italy.

The Chinese have manufactured vermilion for many centuries. In 1880 China imported quicksilver valued at $170,032 (probably from 400,000 to 500,000 pounds), all of which was converted into vermilion.[1] The pigment is still used on a large scale in that country for the making of Chinese red ink, for painting on porcelain and wood, and for coloring candles and paper.

[1] Thorpe; Dictionary of Applied Chemistry.

IMPORTS.

Quicksilver vermilion.—The imports of quicksilver colors show great fluctuations from year to year. There is, however, a gradual increase from a little more than 25,000 pounds in 1894 to an average of nearly 75,000 pounds annually just before the outbreak of the war.[1]

The maximum quantity imported in any one year was in 1907, when 117,134 pounds of this article, valued at $57,049, were imported. This value, however, was exceeded slightly in 1915 and very considerably in 1916 because of the greatly enhanced prices. The quantity imported in the latter year was only 71,305 pounds, but it was valued at $92,919, setting a new maximum value.

The duties (15 per cent) collected on the 1916 importation also set a new record for revenue. They amounted to nearly $14,000, as compared with the previous maximum (1907) of less than $12,000 (10 cents per pound).

Imports by countries are not published by the Department of Commerce, but a survey[2] of the imports during the fiscal year 1914 shows that about 90 per cent of the vermilion (containing quicksilver) imported for consumption in that year was derived from Germany and the remainder from England. It is of passing interest to note that 154 pounds of vermilion "containing cinnabar" (i. e., natural vermilion) was imported from Germany. The declaration value per pound was about 70 cents as compared with only 47 cents for the artificial product.

Chrome red.—The importations of vermilion red "not containing quicksilver, but made of lead or containing lead," show a very marked falling off of some 50,000 or 60,000 pounds prior to 1908 to only about 1,000 pounds or less in 1913 and later years. At no time have these imports been large and recently they have become absolutely negligible. To what extent the decline in the imports of this commodity can be attributed to a change in its classification that would permit of its importation as a chromium color, dutiable at 20 per cent, has not been investigated.[3] The small quantity imported in 1914 came from England and Germany in the proportion of 75 per cent from the former and 25 per cent from the latter country.[2]

PRICES.

The prices of ordinary English vermilion follow with some uniformity the quicksilver metal market. Prior to the outbreak of the war the price of this article averaged between 50 and 60 cents per pound, generally remaining about 5 cents per pound higher than the price of the metal. Chinese vermilion, however, was quoted at almost twice the price of the metal, selling in the vicinity of $1 per pound.

The phenomenal price advances of the quicksilver market during the war period were reflected in the quotations of English vermilion. These rose to a maximum of nearly $4 in the second quarter of 1916 following the maximum quotation for the metal. The gradual readjustment of the quicksilver market in 1917 and 1918 resulted in a

[1] Average imports, 1910-1914, inclusive, 74,749 pounds annually.
[2] Dr. E. R. Pickrell. Dept. of Commerce Misc. Series No. 82.
[3] No definite conclusions can be drawn from the statistics of the chromium colors because of the considerable fluctuations. But there was a sudden increase in the imports of the chromium colors in 1909 coincident with a very great decrease in the imports of American vermilion.

price of about $1.50 for the metal and approximately $2 per pound for the pigment.[1] Early in 1919 the price of quicksilver began to sag a little, but vermilion remained firm until the middle of February. It then fell much more rapidly than did the metal until, in April and May, the differential that has increased to such large proportions during the later years of the war period was reduced to only 10 to 15 cents, or not a great deal more than it was before the war (as reckoned in percentages of the market prices). The metal was quoted in May at a few cents over $1, whereas the quotation for English vermilion was $1.15 (May 5).

The quotations for Chinese vermilion remained stationary during the early part of the war period and after 1915 were nominal. No quotations were published in 1917 and after.

Chrome red prices are not quoted regularly. The market factors are the same as those of chrome yellow. Reference should be made to T. I. S. Unit on Chromium Colors for a discussion of these factors.

TARIFF HISTORY.

Vermilion red and colors containing quicksilver were not mentioned in the act of 1883, but they were specifically provided for in the act of 1890, the duty being fixed at 12 cents per pound. The act of 1894 took cognizance of the existence of a lead compound that was being sold under the same name [2] and provided a duty of 6 cents per pound on its importations; the duty on quicksilver colors was reduced nearly one-third by the adoption of an ad valorem duty of 20 per cent. But in 1897 the duty on quicksilver color was again made specific, being fixed at 10 cents per pound. The duty on lead vermilion was shaded to 5 cents per pound. The same rates were continued in the act of 1909 except for a further slight reduction (one-eighth cent per pound) on the lead pigment.[3] In 1913 an ad valorem rate was again adopted for quicksilver colors and adopted for the first time in the case of the lead color. The rates were 15 and 25 [4] per cent, respectively.

The fluctuations in the quantities of these articles imported in successive years has been so great that it covers up any possible evidence of the effect of tariff changes. It may be noted here, however, that all the above-mentioned duties have allowed a substantial margin above the compensatory duty as based upon the duties levied on quicksilver in the corresponding acts.[5]

TARIFF CONSIDERATIONS.

Quicksilver vermilion is so largely composed of quicksilver metal that its tariff problems are practically the same as those of quicksilver itself. The quicksilver content of pure mercury sulphide is 86.2 per cent, or nearly seven-eighths of the weight, and its cost amounts to about 90 per cent of the selling price of the ordinary domestic grades of vermilion. The importance of considering the compensating duty, in case the duty upon quicksilver is increased,

[1] Government price, $1.40; outside market fluctuated around $1.60.
[2] See Court and Treasury Decisions.
[3] It is interesting to note, however, that the duty on other chrome colors was one-half cent lower per pound (i. e., 4½ cents) than that on this masquerader.
[4] The anomaly between this and the 20 per cent duty on chrome colors has been mentioned.
[5] The duty on quicksilver remained unchanged at 7 cents per pound from 1894 to Oct. 3, 1913, when it was changed to 10 per cent ad valorem.

is evident. Vermilion requires only to be heated in an oxidizing atmosphere to liberate the metal and the cost of reduction of mercury sulphide in any form to the metal is almost negligible.

There seems to be no special reason for listing "vermilion * * * containing lead" in this paragraph. It is distinctly a chromium color and is adequately described in the paragraph that covers such colors.

Vermilion—Production in United States—Official source.

[From Federal census.]

Year.	Quantity.	Value.
	Pounds.	
1909	259,558	$107,472
1914	322,759	200,134

Vermilion reds—Containing quicksilver, dry, or ground in oil or water—Imports for consumption—Revenue.

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1911	10 cents per pound.	89,873	$50,360.00	$8,987.33	$0.563	17.8
1912	....do....	84,546	45,833.00	8,454.60	.541	18.5
1913	....	71,465	36,012.00	6,370.90	.503	17.7
1914	15 per cent	78,050	37,755.00	5,663.25	.484	15.0
1915	....do....	70,622	57,849.00	8,677.35	.818	15.0
1916	....do....	58,635	79,411.00	11,911.65	1.354	15.0
1917	....do....	16,751	24,441.00	3,666.15	1.459	15.0
1918	....do....	2,368	3,134.00	470.10	1.32	15.0
1919	....do....	13,764	21,122.00	3,168.30	1.54	15.0

Vermilion reds, not containing quicksilver, but made of lead, or containing lead—Imports for consumption—Revenue.

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1911	4½ cents per pound.	6,385	$1,704	$311.28	0.268	18.3
1912	....do....	1,622	397	79.10	.245	19.9
1913	....do....	288	77	14.04	.267	18.2
1914	25 per cent	450	154	38.50	.342	25.0
1915	....do....	1,705	304	76.00	.179	25.0
1916	....do....					
1917	....do....	705	80	20.00	.114	25.0
1918	....do....	14	11	2.75	.785	25.0
1919	....do....	152	155	38.75	1.02	25.0

Vermilion, prices (wholesale or retail) per pound at New York.

[From Oil, Paint, and Drug Reporter.]

	English.	American.	Eosine.	Chinese.
August, 1914	$0.55-$0.59			$0.90-$1.00
January, 1915				.90- 1.00
April, 1915				.90- 1.00
July, 1915	1.20			.95- 1.00
October, 1915	1.40- 1.50			.95- 1.00
January, 1916	1.75			.95- 1.00
April, 1916	3.00- 3.50			.95- 1.00
July, 1916	1.50- 1.60			.95- 1.00
October, 1916	1.50- 1.60			.95- 1.00
January, 1917	1.60- 1.50			
April, 1917	2.25- 2.25			
July, 1917	2.00- 1.75			
October, 1917	2.00- 1.80			
January, 1918	2.10- 1.95			
April, 1918	2.10- 1.85			
July, 1918	2.10- 2.00			
October, 1918	2.10- 2.00			
January, 1919	2.00- 2.10		$0.30-$0.75	Nominal.
April, 1919	1.15		.30- .75	Nominal.
July, 1919	1.50- 1.55	$0.25-$0.30		
October, 1919	1.60- 1.65	.25- .30		
January, 1920	1.40	.25- .30		
April, 1920	1.65	.25- .30		
July, 1920	1.70- 1.75	.25- .40		
October, 1920				

Vermilion—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	87	Colors and paints, including lakes, whether dry or mixed, or ground with water or oil, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	57	Vermilion red, and colors containing quicksilver, dry or ground in oil or water.	12 cents per pound.
1894	45	Vermilion red, and other colors containing quicksilver, dry or ground in oil or water.	20 per cent ad valorem.
		Vermilion red, not containing quicksilver but made of lead or containing lead.	6 cents per pound.
1897	54	Vermilion red, and other colors containing quicksilver, dry or ground in oil or water.	10 cents per pound.
		When not containing quicksilver but made of lead or containing lead.	5 cents per pound.
1909	52	Vermilion reds, containing quicksilver, dry or ground in oil or water.	10 cents per pound.
		When not containing quicksilver but made of lead or containing lead.	4½ cents per pound.
1913	59	Vermilion reds, containing quicksilver, dry or ground in oil or water.	15 per cent ad valorem.
		When not containing quicksilver but made of lead or containing lead.	25 per cent ad valorem.

Court and Treasury Decisions.

Spurious vermilion red containing no quicksilver was held dutiable under the act of 1890 as vermilion red because commercially so known. (In re Downing, 56 Fed., 470, of 1893.) Vermilionette was likewise classified. (G. A. 2235, T. D. 14306, of 1893.)

The language "when not containing quicksilver but made of lead or containing lead" is in conflict with the language in paragraph 54, "all other chromium colors in the manufacture of which lead and bichromate of potash or soda are used." The only pigment which could be classified under this provision in paragraph 59 is American vermilion, which is basic lead chromate (see par. 54), distinctly a chromium color. As this pigment is described by the language "all other chronium colors in the manufacture of which lead and bichro-

mate of potash or soda are used," in paragraph 54, and as vermilionette is a coal-tar lake which comes within the act of 1916 as well as this paragraph, there is no apparent reason for the provision in paragraph 59.

WHITING AND PARIS WHITE.

(See Chalk, paragraph 15)

ZINC PIGMENTS.

[Par. 61, act of 1913. For Lithopone, see par. 10.]

SUMMARY.

DESCRIPTION AND USES.

The important zinc pigments are zinc oxide, leaded-zinc oxide, and lithopone. (Lithopone is discussed more in detail under par. 10.)

Zinc oxide pigments contain 98 per cent or more of oxide of zinc in the form of a white, impalpable powder. The main division is that based on the method of manufacture. French process oxide is made by oxidizing the vapor of boiling zinc, while American process oxide is made direct from the ore.

Leaded zinc oxides are similar to zinc-oxide pigments except that they contain, in addition to the oxide of zinc, varying amounts of basic sulphate of lead.

Lithopone is a chemical precipitate consisting of zinc sulphide and barium sulphate.

The chief use of zinc pigments is in the manufacture of paint, and the enormous growth of the mixed-paint industry has to a large measure been due to the increasing use of these relatively cheap substitutes for white lead. A new and very important use for zinc oxide and lithopone is in the manufacture of vulcanized rubber goods, notably automobile tires. Zinc pigments are also used for loading oilcloth and linoleum, in matches, candles, and in printing inks. An especially high grade of chemically prepared zinc oxide is used in medicine and in many pharmaceutical preparations.

DOMESTIC PRODUCTION.

The amount of zinc oxide and leaded zinc oxide manufactured in the United States is not published. In general, it may be said that the production of high-leaded zincs has shown an enormous increase. The growth in the production of lead-free oxide has not been so rapid.

As its name implies, American process oxide is an American development and the process has not been used to any great extent in other countries. The output of American process oxide is in excess of the domestic requirements and leaves a small margin for export. Approximately 15,000 tons of American process oxide are exported annually.

All of the French process oxide used in the United States was imported before the war, and at the present time the output of this material is insufficient.

For a great many years the zinc-pigment industry in the United States was in the hands of one large corporation, and this company is still the dominant manufacturer. In recent years, however, several other smelting companies have contributed large tonnages of leaded-zinc oxide and small amounts of the lead-free material. Since the pigment business of the main producers is only a branch of their operations, the capitalization of the industry is difficult to estimate. There were 13 plants owned by 9 companies manufacturing lithopone in the United States in 1917.

Most of the pigment manufacture is in the Eastern States or near the zinc-smelting regions of the Mississippi Valley. One of the oldest pigment plants, however, is located in Colorado.

IMPORTS.

Zinc oxide (containing less than 5 per cent of lead) has been imported into the United States in both the dry state (crude pigment) and mixed with oil (mixed paint). The imports consisted wholly of French process oxide, which was not made in appreciable amounts in the United States prior to the war. Only about 400,000 pounds of oxide were imported in the form of mixed paint and the imports were falling off. At the outbreak of the war the supply of French process oxide was cut off, but after 1915 the demand for this material was met by domestic manufacture.

REVENUE.

The tariff reduction of the act of 1913 was followed by a general increase in the amount of imports but lowered considerably the revenue obtained in the form of duties.

PRICES.

The prices of zinc oxides vary with the price of spelter and with the physical and chemical characteristics of the product. Except for a short time in the early months of the war, when the price of oxide was kept down by the producers in order not to force the consumers to go out of business or to substitute other pigments, the price of zinc contents of zinc oxide has been invariably higher than the price of the same amount of zinc in the form of metal. The differences between the different grades are variable.

TARIFF HISTORY.

The general trend of tariff legislation has been a lowering of the duty on zinc products of all kinds. Until the act of 1913, however, duties on the zinc pigments had been changed only once. The last act reduced the duty on zinc oxide by nearly 6 per cent ad valorem (from 16 per cent to 10 per cent and from 20.5 to 15 per cent).

COMPETITIVE CONDITIONS.

The manufacturers of American process oxide occupy a very advantageous position and control both the domestic and foreign market for this material.

The manufacturer of French process oxides is dependent on the zinc-metal market for his raw material, and compensating duties are necessary to cover the duty on zinc metal.

Zinc oxide, dry—Summary table.

Fiscal year.	Domestic production.[1]	Imports for consumption.	Domestic exports.[2]	Ratio to production.	
				Imports.	Exports.
	Pounds.	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*
1910	116,962,000	6,626,902	27,149,378	5.67	23.21
1911	127,654,000	5,262,770	27,866,979	4.12	21.83
1912	168,004,000	4,842,948	32,792,882	2.88	19.52
1913	151,400,000	6,148,120	31,035,147	4.06	20.50
1914	165,618,000	6,723,969	29,197,790	4.06	17.63
1915	218,522,000	2,557,434	37,580,411	1.17	17.20
1916	200,678,000	1,441,299	31,222,228	.72	15.56
1917	215,172,000	285,433	31,486,877	.13	14.63
1918	200,572,000	294,736	25,862,063	.15	12.89
1919	235,278,000	132,486	26,051,535	.06	11.07

Year.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
1910	$379,446.00	$66,269.02	$0.057	17.47
1911	331,338.00	52,627.70	.063	15.88
1912	310,362.00	48,429.48	.064	15.60
1913	389,485.00	61,481.20	.063	15.78
1914	397,516.00	44,992.22	[3] .063 .058	[3] 15.93 10.00
1915	144,355.00	14,435.50	.056	10.00
1916	244,934.00	24,493.40	.170	10.00
1917	65,633.00	6,563.30	.230	10.00
1918	55,302.00	5,530.20	.188	10.00
1919	30,346.00	3,034.60	.229	10.00

[1] Calendar years.
[2] Includes leaded zinc oxide.
[3] First figure for July 1–Oct. 3, 1913, under act of 1909. Second figure for Oct. 3, 1913–June 30, 1914, under act of 1913.

General Information.

[Par. 61, act of 1913.]

"Zinc, oxide of, and pigments containing zinc but not containing more than 5 per centum of lead, ground dry, 10 per centum ad valorem; when ground in or mixed with water or oil, lithopone, and white sulphide of zinc, 15 per centum ad valorem."

DESCRIPTION AND GRADES.

There are three types of zinc pigments on the market: (1) Zinc oxide, (2) leaded zinc oxide, and (3) lithopone. Each of these types is manufactured in several grades, depending on the method of manufacture and quality of the raw material.

(1) *Zinc oxide* is the most important of the zinc pigments, and is known by various names, such as zinc white, Chinese white, flowers of zinc, blanc de zinc (de neige), fleures de zinc, zinkweiss, etc. In addition to the grades used for pigment, chemically precipitated zinc oxide of extreme purity is used in pharmacy. This is the highest grade of zinc oxide and is mentioned only for the sake of completeness, since it was not produced in the United States until the present war and is a very unimportant product as compared to the wide technical uses of other less pure grades. The latter are obtained by the chemical union of metallic zinc and oxygen; that is, by burning zinc in air. Oxides for use as pigments, therefore, have the properties of a fume, impalpable and very finely divided.

Practically all grades of lead free zinc oxide contain 98 per cent or more of oxide of zinc (ZnO). Variation in composition is very slight and the grading is based largely on physical qualities. The better grades are a pure and permanent white, unaffected by hydrogen sulphide or other gases. The material is sampled, rubbed down with oil, and compared chemically and physically with standard samples. For use in rubber making, slight variations in color are not important, but freedom from lead and absence of hard particles is required, and fineness and uniformity are insisted upon to an even greater extent than in paint making.

American zinc oxides are divided into two main groups, depending on the process of manufacture: (*a*) French process oxides and (*b*) American process oxides.

(*a*) *French process zinc oxides* are made by distilling spelter (zinc which has previously been recovered from the ore) and allowing the fume to oxidize in the air. For this reason the process is also called the "indirect process." These oxides were formerly manufactured only on the Continent, but in recent years American manufacturers have been producing products equal and even superior to those made in France and Belgium. They are expecially adapted to the manufacture of the highest quality surgical rubber goods, high-grade enamels, toilet preparations, printing inks, glues, artificial ivory, and false teeth.

(*b*) *American process lead free zinc oxides* are made directly from the ore and are therefore often referred to as "direct process" oxides. As lead—free ores are necessary for the manufacture of lead—free oxide, the domestic production was in the hands of one company. The lead content is held below 2 per cent and the color, while not as bright as the French process brands, is nevertheless much better than that of leaded oxides. The chief use for this grade is in the rubber trade, but large tonnages are used in the manufacture of enamel ware, porcelain, tile, glass, oilcloth, matches, etc.

(2) *Leaded zinc oxides* contain comparatively high amounts of lead in the form of basic sulphate. They are made by the direct or American process from ores containing, in addition to zinc, more or less lead, whereas zinc oxides are made from ores that are practically free from lead. As most zinc ores contain lead, this type of ore is much more plentiful than those with only the one volatile metal, and the pigments made from it are less expensive than when careful selection of lead-free ore is necessary. The amount of lead in leaded oxides depends on the selection of the ore and varies with the different producers. The price per pound is in inverse proportion to the lead content, and the pigments containing lead are heavier than those that are lead free. The lead is not merely present as a mechanical mixture but apparently is closely bound to the zinc oxide. The commercial brands range from 3 to 37 per cent lead (as $PbSO_4$). The lower lead product is produced chiefly from Wisconsin ores. Leaded zincs from Missouri are similar, but the lower lead content can never be reached, while the standard zinc-lead white of Colorado contains equal amounts of zinc oxide and lead sulphate.

(3) *Lithopone* is a product entirely different in chemical composition from the other zinc pigments. It does not contain zinc oxide. The zinc is present as the sulphide and is mixed with barium sulphate. It is much cheaper than any of the zinc oxides, even those with a com-

paratively high lead content. Whereas pure zinc oxide contains about 80 per cent metallic zinc, lithopone contains less than 20 per cent. Lithopone also differs in that it is made as a chemical precipitate from solution, while practically all commercial zinc oxides are made by sublimation in the dry way.

As compared with zinc oxide, lithopone is a coarse-grained pigment, but it is brilliantly white, has strong tinting properties and good covering power. The most important use is in the making of the beautiful finishes known as flat wall paints. The pigment in these paints consists of from 75 to 100 per cent lithopone. The only drawback to lithopone is the fact that it is likely to turn dark gray when exposed simultaneously to the action of moisture and sunlight; however, the whiteness usually returns when these disturbing agencies are removed.

Lithopone is also used in the manufacture of such articles as linoleum, table oilcloth, and window-shade cloth, and has also invaded the rubber field, being used to some extent as a substitute for a certain amount of the higher grade fillers in the manufacture of mechanical rubber goods.

The quality of lithopone is greatly affected by the care taken in its manufacture and by the purity of the chemicals used.

USES OF ZINC PIGMENTS.

The zinc pigments, especially the oxides, are finding a comparatively new and a very important use in the manufacture of vulcanized rubber goods of which the most important are automobile tires. They are incorporated into the mixture before vulcanizing. The function of zinc oxide in rubber making is not merely that of a pigment for producing white goods, but it adds materially to the strength of the vulcanized rubber. Up to about 60 per cent of the mix, the addition of zinc oxide increases the tensile strength of the product without seriously lowering the elongation. A maximum increase in strength of 25 per cent more than the strength of ordinary vulcanized rubber containing only gum and sulphur can be obtained by the use of zinc oxide. No other mineral filler now known yields so great an increase. Lithopone is the nearest competitor, but leaded zinc oxides can not be used.

The principal consumption of zinc pigments is, of course, in the making of paints, and the rapid strikes made by the prepared-paint industry is to a large extent attributable to the development of these highly satisfactory and rather cheap pigments. The main advantage of zinc paints is that they are not discolored by sulphureted hydrogen which has the property of turning white lead brown. Its disadvantages are slow drying and its tendency to become unduly hard in time. The extreme hardness renders it less resistant to temperature changes. When used alone, the paint cracks and peels off in patches, making repainting expensive, whereas white lead paint will "chalk" or dust off. The consensus of opinion among paint manufacturers is that a mixture of pigments is preferable to any one pigment used alone, and zinc oxide is now an almost invariable constituent of these mixtures. When used with other pigments, zinc oxide prevents chalking and gives a surface that retains its color. The combination with other pigments prevents the cracking of the coat.

Minor uses of zinc pigments are for loading and filling oilcloth and linoleum, in matches, candles, and printing inks. The use of high-grade zinc oxide made in the wet way for medicinal use and pharmaceutical preparations and toilet accessories has been mentioned.

DOMESTIC PRODUCTION.

Development of the industry.—The use of zinc pigments is comparatively new, as it has been developed during the last 75 years. The greatest impetus to the industry was the invention of the American or direct process of manufacturing zinc oxide direct from the ore. Prior to this invention in 1854, the oxide had been produced in only a small way. A little yellowish paint pigment had been made by grinding up the red zincite (natural zinc oxide) ore found at Franklin Furnace, N. J., in association with two other unusual ores of zinc, franklinite and willemite. The latter is the source of very pure spelter and zinc oxide. It is a silicate of zinc and is invariably associated with the oxide. The mixed minerals have formed a considerable proportion of the zinc ore exported and have been used in great quantities for making zinc oxide in Europe.

The treatment of franklinite, a mineral containing zinc, iron, and manganese in the form of oxides, was a most serious problem whose solution has been the backbone of the zinc-oxide industry in the United States.

Since all the above ores have been controlled by the New Jersey Zinc Co., this company was formerly the only, and is still the largest producer of zinc pigments in the world. The recent applications of leaded zinc in the paint trade and the discovery of other lead-free ores have allowed other manufacturers to make these products. But even in this field the older organization at its plant at Mineral Point, Wis., is the leading producer. The history of the zinc pigment industry has been closely linked with this company and its growth is largely due to the enterprise of this corporation.

Methods of manufacture.—(1) *Zinc oxides* are manufactured for paint by two types of processes: (*a*) The French process, in which the vapor given off by a boiling bath of zinc metal is oxidized and the fume collected; and (*b*) the American or direct process, in which zinc ore is mixed with coal, heated to reduce and volatilize the zinc, and the resulting vapor oxidized and collected.

The raw material required for the French process is spelter or zinc previously reduced from the ore. A cheaper grade is made, using the metallic zinc liquated from galvanizer's dross. The raw materials for the American process are zinc ore (preferably oxide, carbonate, or silicate, but roasted sulphide can be used) and coal or other reducing agent.

(*a*) *The French process* is very simple. The metal is charged into a suitable vessel and heated to the temperature of volatilization. The zinc vapor rises from the surface of the molten metal and oxidizes as soon as it comes in contact with the air. The resulting fume is cooled in flues and chambers and finally drawn through bags, which filter out the finely divided particles of zinc oxide and allow the gas to escape up the stack.

(*b*) *The American process* consists essentially in spreading a mixture of coal and ore on a perforated grate and blowing an excess of air

through the grate. The zinc content of the ore is thereby reduced to metal, volatilized, and then burned in the excess of air in the upper part of the furnace and in the flues. The process is applicable to all the oxidized ores of zinc (oxide, carbonates, and silicates) or to the roasted sulphide, provided the gangue (waste rock) is not so fusible as to sinter together and form a mass that is impervious to the blast. Even fusible ores can be used if infusible material is added to keep the bed porous.

Ore.—While the process can be worked on most ores, not all ores are sufficiently pure to yield a product with a good enough color to make it available as pigment. In general any impurity that will form a colored oxide or sulphide is deleterious. *Cadmium* is one of the commonest. Being very volatile, it always enters the fume. Its dark brown oxide and bright yellow sulphide both have strong tinctorial powers. A fraction of 1 per cent of this element in these forms seriously affects the color of the pigment. It is usually possible to convert cadmium in the pigment to the white sulphate or carbonate, and analyses of the 12 leading brands of zinc oxide, French process, lead free, and leaded grades on the market show 0.02 to 0.35 per cent cadmium (or up to 0.45 per cent, if figured as sulphide), but they are of satisfactory color.[1]

Lead, which is of almost universal occurrence in zinc ores, also injures the color, but to a much less degree (in spite of the fact that its sulphide and oxides are black or colored) than cadmium, because a basic sulphate, which is white, is generally formed. Since zinc oxide containing over 0.2 per cent lead can not be used in rubber making, practically lead-free ores must be selected for making the higher grades of zinc oxide. *Sulphur* may be found in the fume in the form of sulphide, sulphate, or sulphurous anhydrides. The first form is the most objectionable as to injuring the color, but the last-mentioned compound is believed by most, though not all, paint manufacturers to have a bad effect on the grinding properties of the pigment. Sulphates, if soluble, are exceedingly undesirable, since, especially in outside paints, they are liable to be leached out from the coat, leaving discolored spots. (The desirability of a low sulphur content of the furnace charge is evident.) *Chlorides* in appreciable quantity are rarely evolved from the charge, but should they be present in appreciable amounts in the fume they are open to the same objection as sulphates.

Fuel.—The main requirement of the fuel is that it must not produce a black smoke. In the West, where anthracite is expensive, semibituminous coal, low in volatile matter, is sometimes substituted for the harder coal, but is not so good. Coke does not work well because it produces a locally intense heat, which may cause sintering and make the charge impervious to the blast. It is, however, used occasionally as a part of the charge fuel, although never alone.

Limestone.—Lime flux is often added to siliceous ores to aid in their reduction, but it generally does more harm than good since it tends to make the residue too fusible.

Both ore and coal as usually received at the oxide plant are fine enough to obviate the necessity of further crushing; the ore is concentrated at or near the mine and is therefore fine enough, while the

[1] L. E. Wemple, Discussion, Trans. A. I. M. E. LVII (1918), p. 694.

smaller sizes of coal, being suitable and generally cheaper, are almost invariably used. If fluxes (limestone, etc.) are employed, a small crusher must be installed to break them down to approximately the same size as the rest of the charge.

A good example of zinc pigment works is that of the New Jersey Zinc Co., at Palmerton, N. J. This works has been described in detail,[1] and the description with cuts of the furnaces and plans of the works are available in the auxiliary file.

At this plant the ores consist almost wholly of concentrates from the company's mines at Franklin furnace. They are divided into three classes as received. The average analyses of these ores illustrate the difference in composition.

Name of ore.	Zinc.	Iron.	Manganese.	Silica.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Franklinite	18.2	35.0	12.8	3.6
"Half and half"	18.4	15.2	12.2	12.6
Dust	17.6	20.1	8.9	7.2

The franklinite is worked by itself. The residue is rich in manganese and is reduced to spiegeleisen in a small blast furnace. The spiegeleisen is sold to makers of Bessemer steel.

The quality of the fume and the amount recovered depend on the selection of ore, the ratio of ore to coal, the ratio of both (ore and coal) to the grate surface, and, most important of all, the correct proportioning of blast and exhaust to the charge worked. Considerable care and experience are necessary to make a high-grade oxide.

The recovery, expressed in percentages of the total zinc in the charge recovered as zinc in the fume, is never very high, as some zinc is inevitably left in the residue. The zinc recovery from franklinite averages about 86 per cent and that from the "half and half" and fines, which are worked together in the same charge, is about 78 per cent.

PRODUCTION.

There are no published production statistics covering the manufacture of lead-free or leaded zinc oxides. In the census reports the productions of the various paint industries can not be satisfactorily separated. The manufacture of white lead or zinc white is the principal business of some concerns; some are engaged wholly in paint mixing, while other establishments make both crude pigments and mixed paints.

In addition to the products listed above, there were manufactured by smelters direct from the ore 106,791 tons of pigments, valued at $9,978,710, in 1914, as compared with 87,525 tons, valued at $7,963,332, in 1909. Since zinc oxide and leaded zinc oxide are practically the only pigments manufactured direct from the ore by a smelting process (the production of high lead fume is probably only a comparatively small fraction of such pigments) these figures can be assumed, without much exaggeration, to represent the combined productions of these two commodities by the American process. The above figures show an increase of 22 per cent in the amount of product

[1] Geo. C. Stone, Oxide of zinc, Trans. A. I. M. E. LVII, pp. 682–695.

and an increase of 25.3 per cent in its value for the five-year period. The growth of the industry has been as rapid since 1914.

There are no data at hand covering the production of French process oxides. This is a comparatively new industry in the United States and has seen the most of its development since the outbreak of the war.

The growth of the zinc-pigment industry is illustrated by the following table, which shows the zinc content of zinc pigments made in the United States (from both foreign and domestic ore):

Primary zinc content of zinc pigments made in the United States, 1908–1915.[1]

Year.	Short tons.	Year.	Short tons.
1908	48,004	1912	64,032
1909	54,139	1913	70,622
1910	59,592	1914	70,619
1911	46,122	1915	79,572

[1] Mineral Resources U. S. Geol. Survey.

EXPORTS.

The only zinc pigments exported in any quantity from the United States are American process oxides. In 1909 these exports amounted to about 27,000,000 pounds, or approximately 25 per cent of the domestic production. The maximum exportation was in 1915, when over 37,580,000 pounds of zinc oxide, valued at $1,808,970, were exported. In 1916 and 1917 the amount exported was practically the same as in the prewar period, running a little more than 31,000,000 pounds annually, but the enhanced price increased their value to fully three times that of the annual exports before the war.

The heaviest exports of zinc oxide have always been to England, and before the war the only important importers of American zincs were European countries. Even Germany, the chief producer of French process oxide, imported over 2,000,000 pounds of the cheaper American material to be used in the making of lower-grade paints. A steadily increasing amount has been shipped to Canada, and during the war period the amount increased over 100 per cent. An important effect of the cutting off of supplies from the Central Powers and Belgium has been the diversion of a large part of the exports that formerly went to European countries to South America. While the amount of exports has not increased appreciably, this transfer of their destination may be important. The mixed-paint business has grown so rapidly that it has left little margin of American process oxides to be exported as crude pigment, particularly in the face of lessened importations.

FOREIGN PRODUCTION.

Data as regards foreign production are lacking. The United States is the only important producer of American process oxide. Prior to 1914 Germany was doubtless the leading producer of zinc oxide by the French process and was followed in close order by Belgium, Holland, and France. Very little American process oxide has been produced in Europe, due to the expense of the anthracite coal, and a

general lack of ore of the necessary purity. Practically the only source of the product was the Dutch imports of willemite (high-grade zinc ore) from New Jersey. About 20,000 tons of this ore were annually shipped from the United States to the Netherlands and were all used in the making of pigment.

There is very little leaded zinc oxide manufactured outside of the United States. Recently a small output has developed in Italy.

IMPORTS.

Since October 4, 1913, the classification of imports of zinc pigments adopted by the Department of Commerce has been as follows: Zinc oxide containing less than 5 per cent of lead (zinc oxide largely, but also includes some of the higher grades of leaded zincs), (1) dry and (2) ground in oil or water (mixed paints); lithopone; zinc sulphide.

Prior to the above date the distinction between zinc oxide and leaded zinc with large amounts of lead was not made. Importations of the latter class of pigments have never been more than a negligibe amount.

Tlhere was a large and steady importation of zinc pigments before the outbreak of the European war. These consisted of French process oxides and lithopone. About five million pounds of high-grade zinc oxide (dry) was imported annually from Germany, Belgium, and France. At that time no zinc oxide was made from spelter in the United States and it is doubtful if it would have been profitable to make it from American spelter, as the metal sold at a much higher price in the United States than in Europe. The imports of high-grade mixed paints was only a fraction of those of the cruder pigment and averaged less than 400,000 pounds annually.

By the wording of the 1913 act, zinc oxide containing up to 5 per cent of lead was classified with the highest grade or lead-free oxide; whereas leaded zincs were not included in this classification previously. This broadening of the classification had slight effect, however, on the importation because the domestic demand for leaded oxide even the higher grades has always been supplied by domestic manufacturers. Since French process oxide was not manufactured in the United States prior to 1915, the increase of nearly 20 per cent that followed the reduction of the duty on the dry pigment is due to the fact that it could be obtained at a lower price and could therefore compete on more nearly equal terms with American process pigment.

The tariff reduction in the case of zinc oxide ground or mixed with oil or water (mixed paint) served temporarily to check the steady decline in these imports that had been in progress since 1912. The imports in 1914 were practically equal to those of the preceding year.

The lowered duties on zinc pigments resulted in a marked reduction in the amount of revenue collected by the Government. This was most marked in the dry oxide and lithopone import duties. Although the amount of the former increased almost 20 per cent and the latter (including "zinc sulphide") nearly doubled, the reduction in revenue was from $61,500 to $41,200 [1] and from $64,500 to $46,900 [1] or 33 per cent and 27 per cent, respectively.

[1] Calculated to a basis of 12 months.

The outbreak of the great war cut off the European supplies of all zinc products and naturally resulted in a rapid falling off of the imports of all kinds of zinc pigments.

PRICES.

The price of all zinc pigments is normally dependent on the price for spelter, and the zinc contents of even the lower grades of American process leaded zinc sell at a slightly higher price than their value in terms of spelter. The only exception to this rule was in the first few months following the outbreak of the European war. Spelter prices then soared to above 30 cents a pound. French process oxide, being produced directly from the metal, promptly reflected the advanced prices and was hard to get because of the cutting off of German shipments and the general stringency of spelter. The price of American process oxide, however, was held back within moderate limits by the producers in order not to unduly hamper the paint industry which had become largely dependent on this product. When spelter was selling at from 20 to 30 cents a pound, the same amount of zinc was sold as oxide at a price less than half that of the metal.

Quotations for the various grades of oxide are listed on page 165 of this survey.

The average price received by makers of lithopone in 1917 was approximately $116.06 a short ton, or 5.8 cents a pound, as compared with quoted wholesale prices, which ranged from 6 to 9⅝ cents a pound, being generally 6½ to 7 cents a pound throughout the year.[1]

COMPETITIVE CONDITIONS AND TARIFF.

The duties fixed by the act of 1913 were so low as to permit of fairly active competition between domestic and foreign supplies of all zinc pigments. Even the importation of French process oxide, which at that time was not being manufactured in the United States, was increased because its lowered price placed it in a position to compete on more nearly equal terms with the American process oxides. While the imports of all zinc pigments were increased, the revenue derived from the duties collected were cut one-third on imports of dry zinc oxide and nearly as much on lithopone.

The competitive status of the domestic manufacturers of American process zinc oxide is excellent, and it is not likely that any foreign oxide of this character would be imported even if it were placed on the free list.

The domestic manufacture of French process oxide is a result of war conditions. Its survival is more closely linked with the spelter industry than is that of any of the other zinc base pigments, all of which require compensatory duties to cover the duty on spelter, which may, in the future as in the past, determine the differential between the foreign and the domestic quotations on the metal.

Zinc oxide ground in oil (paste) is not now an important item, as American pigment grinders are equipped to meet foreign competition

[1] James M. Hill, Mineral Resources. U. S. Geol. Survey, Barytes, etc., 1917. Advance publication. (Vol. II, p. 290.)

as long as they are assured of their supplies of raw material (which in this case includes linseed oil as well as zinc oxide).

Zinc oxides containing more than 5 per cent of lead are not given specific mention, therefore are classed with lead pigments. (Par. 56.) Under the present classification of lead free and leaded zincs, American process leaded oxides are dutiable at a higher rate and at a greater amount per pound than are lead free oxides.

The lead content of leaded oxides containing up to 20 per cent lead sulphate requires no protection regardless of the duty imposed on lead ore and metal. The lead in the ores from which leaded oxides are produced can not be separated economically from the zinc, and its presence lowers the value of the ore for either zinc oxide or zinc metal manufacture.

Zinc oxide—Production in United States.

[From Mineral Resources, United States Geological Survey.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1900	48,840	$3,667,210	1914	82,809	$7,850,350
1908	56,292	5,072,460	1915	109,261	11,984,470
1909	68,974	6,156,755	1916	100,339	18,816,378
1910	58,481	5,238,945	1917	107,586	21,589,976
1911	63,827	5,816,370	1918	100,286	20,560,247
1912	84,002	7,482,409	1919	117,639	20,591,877
1913	75,700	7,161,528			

Leaded zinc oxide—Production in United States.

[From United States Geological Survey.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1908	8,430	$778,200	1914	11,317	$977,431
1909	7,655	634,714	1915	18,758	1,724,145
1910	6,823	621,120	1916	23,008	3,053,060
1911	6,765	561,560	1917	23,450	3,728,976
1912	11,410	953,800	1918	26,714	4,480,565
1913	9,421	745,698	1919	27,591	4,009,024

Zinc, oxide of, and white paint, or pigments containing zinc, but not containing lead, dry—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	1 cent per pound	4,807,065	$289,285.00	$48,070.65	$0.06	16.62
1908	do	4,703,262	278,456.00	47,032.62	.059	16.89
1909	do	5,602,259	311,588.00	56,022.59	.056	17.98
1910	do	6,626,902	379,445.88	66,269.02	.057	17.47
1911	do	5,262,770	331,337.88	52,627.70	.063	15.88
1912	do	4,842,948	310,362.00	48,429.48	.064	15.60
1913	do	6,148,120	389,485.00	61,481.20	.063	15.78
1914	do	1,408,162	88,410.00	14,081.62	.063	15.93

[1] July 1 to Oct. 3, 1913, under act of 1909.

Zinc, oxide of, and white paint, or pigment containing zinc, but not containing lead—Ground in oil—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	1¼ cents per pound.	305,511	$35,162.00	$5,346.46	$0.115	15.21
1908	....do....	322,314	29,078.00	5,640.50	.09	19.40
1909	....do....	359,115	34,442.30	6,284.54	.096	18.25
1910	....do....	473,560	43,191.00	8,287.32	.091	19.19
1911	....do....	467,398	33,905.00	8,179.50	.072	24.13
1912	....do....	565,224	44,637.00	9,891.42	.079	22.16
1913	....do....	320,656	27,295.00	5,611.48	.085	20.56
1914 [1]	....do....	62,065	5,302.00	1,086.14	.086	20.48

[1] July 1 to Oct. 3, 1913, under act of 1909.

Zinc, oxide of, and white paint, or pigment containing zinc, but not containing lead—Sulphide of, white, or white sulphide of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	1¼ cents per pound.	1,395,518	$44,643.00	$17,444.01	$0.032	39.07
1908	....do....	1,208,849	41,537.00	15,110.64	.034	36.38
1909	....do....	1,316,081	50,749.00	16,451.02	.039	32.42
1910	....do....	2,307,699	68,925.00	28,846.23	.029	41.85
1911	....do....	5,409,520	145,201.00	67,619.06	.027	46.57
1912	....do....	6,325,072	157,921.00	79,063.45	.025	50.07
1913	....do....	5,163,642	144,812.00	64,545.55	.028	44.57
1914 [1]	....do....	847,563	25,777.00	10,594.55	.030	41.10

[1] July 1 to Oct. 3, 1913, under act of 1909.

Zinc, oxide of, and pigment containing zinc but not containing more than 5 per cent of lead, ground dry—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914 [1]	10 per cent....	5,315,807	$309,106.00	$30,910.60	$0.058	10.00
1915	....do....	2,557,434	144,355.00	14,435.50	.056	10.00
1915 [2]	Free, Sec. IV, J5..	8,000	3,748.00	....	.468	....
1916	10 per cent....	1,441,299	244,934.00	24,493.40	.170	10.00
1917	....do....	285,433	65,633.00	6,563.30	.230	10.00
1918	....do....	294,736	55,302.00	5,530.20	.188	10.00
1919	....do....	132,486	30,346.00	3,034.60	.229	10.00

[1] Oct. 4, 1913, to June 30, 1914, under act of 1913. [2] For construction and equipment of vessels.

Zinc, oxide of, and pigment containing zinc but not containing more than 5 per cent of lead—Ground in or mixed with oil or water—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914 [1]	15 per cent....	292,571	$21,595.00	$3,239.25	$0.074	15.00
1915	....do....	156,451	11,525.00	1,728.75	.074	15.00
1916	....do....	66,347	7,187.00	1,078.05	.108	15.00
1917	....do....	14,089	1,225.00	183.75	.087	15.00
1918	....do....	273	57.00	8.55	.209	15.00
1919	....do....	7,088	1,059.00	158.85	.149	15.00

[1] Oct. 4, 1913, to June 30, 1914, under act of 1913.

Zinc, sulphide of, white—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914[1]	15 per cent	491,436	$16,353.00	$2,452.95	$0.033	15
1915	do	283,356	8,979.00	1,346.85	.032	15
1916	do	96,402	7,368.00	1,105.20	.076	15
1917	do	53,587	8,451.00	1,267.65	.158	15
1918	do	7,098	4,535.00	680.25	.639	15
1919	do	5,703	1,837.00	275.55	.322	15

[1] Oct. 4, 1913, to June 30, 1914, under act of 1913.

Zinc oxide—Domestic exports (fiscal years).

Exported to—	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Austria-Hungary	391,703	$13,015	393,715	$13,749	412,333	$15,300
Belgium	299,302	9,475	578,690	19,075	268,015	9,200
Denmark	2,800,349	88,956	4,467,675	149,150	3,522,200	110,665
France	3,985,150	125,776	4,821,355	163,700	3,483,920	122,628
Germany	1,986,215	64,786	1,834,155	62,740	2,259,323	77,285
Italy	975,217	31,150	937,328	32,026	894,925	30,205
Netherlands	2,580,494	84,237	1,943,585	66,942	2,144,798	77,240
Russia in Europe	680,350	22,475	.....	.....	439,014	15,510
England	10,794,227	388,885	9,835,624	351,423	11,110,093	398,081
Scotland	649,824	23,658	613,750	23,050	728,100	26,540
Canada	1,475,281	66,967	1,306,252	58,456	2,224,510	100,743
Panama	25,625	800	19,935	1,013	67,135	4,344
Mexico	17,612	916	600	38	.....	.....
Australia	179,010	6,465	292,380	10,400	65,200	2,170
All other	115,638	4,108	104,334	4,698	247,413	9,250
Total	26,955,997	931,669	27,149,378	956,460	27,866,979	999,161

These figures are for both dry and oil.

Exported to—	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Austria-Hungary	295,903	$11,065	350,967	$13,250	24,254	$1,000
Belgium	582,116	20,467	511,568	19,140	339,488	13,950
Denmark	4,306,800	136,130	2,946,150	93,125	2,395,845	92,281
France	4,630,283	164,890	3,834,366	143,600	3,040,186	123,717
Germany	3,038,019	112,230	2,778,733	104,920	2,773,149	111,283
Italy	1,342,012	48,676	822,484	30,450	1,760,144	72,400
Netherlands	2,646,622	95,230	1,573,017	60,448	987,916	39,916
Russia in Europe	949,678	33,175	630,625	24,700	630,629	24,470
England	10,967,058	388,808	12,098,352	428,439	12,088,838	493,473
Scotland	840,000	30,200	663,488	23,596	695,450	28,152
Canada	2,835,489	128,283	4,344,530	201,563	3,989,013	192,827
Panama	34,788	1,913	106,015	6,309	114,827	7,086
Mexico	517	30	4,731	169	2,000	145
Australia	208,320	7,382	232,850	8,449	266,940	10,359
All other	115,277	4,204	137,271	6,431	89,111	4,307
Total	32,792,882	1,182,683	31,035,147	1,164,589	29,197,790	1,215,366

Zinc oxide—Domestic exports (fiscal years)—Continued.

Exported to—	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Belgium	48,510	$2,050				
Denmark	1,369,210	61,505	321,490	$25,457	561,890	$51,018
France	1,858,275	80,906	1,797,205	118,570	3,821,433	379,237
Germany	207,548	8,850				
Italy	1,535,930	68,959	752,265	53,600	1,170,574	105,105
Netherlands	24,254	1,000			552	112
Russia in Europe			22,500	1,397	351,250	32,750
England	23,735,494	1,157,293	17,723,677	980,373	13,259,373	1,322,918
Scotland	1,953,540	92,722	1,736,400	113,422	707,696	74,310
Canada	6,005,763	292,415	7,796,523	576,075	8,620,315	787,106
Brazil	171,490	11,086	107,772	10,309	651,940	64,522
Panama	5,900	341	34,969	3,357	63,634	7,163
Mexico	20,313	1,209	45,161	3,122	96,893	13,452
Dutch East Indies	10,826	475	250	23	339,049	49,981
Russia in Asia					289,804	27,659
Australia	203,960	8,732	3,003	535	658,125	79,909
All other	429,398	21,427	879,013	74,349	894,409	100,777
Total	37,580,411	1,808,970	31,222,228	1,960,589	31,486,877	3,096,019

Exported to—	1918		1919	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Denmark			477,409	$57,676
France	665,550	$84,450	2,563,450	330,224
Italy	551,250	57,000	441,000	58,992
Russia in Europe	372,100	48,000	10,000	1,391
England	8,222,140	831,783	5,649,770	600,084
Scotland	943,040	95,040	282,240	28,235
Canada	8,330,717	792,758	7,229,560	687,353
Brazil	3,948,830	482,311	3,681,331	481,801
Panama	83,437	11,858	214,272	29,839
Mexico	216,602	34,764	316,076	50,839
Dutch East Indies	191,399	25,079	697,452	88,244
Russia in Asia			13	4
Australia	472,679	56,744	625,014	74,866
All other	1,864,919	250,828	3,863,948	534,650
Total	25,862,063	2,750,610	26,051,535	3,024,198

Zinc oxide and pigments, prices per pound wholesale New York, spot.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	January, 1912.	April, 1912.	July, 1912.	October, 1912.	January, 1913.	April, 1913.	July, 1913.	October, 1913.
German:[1]	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Red Seal	7½– 8½	7½– 8½	7½– 8½	7⅞– 8⅝	7⅞– 8⅝	7⅞– 8⅝	7⅞– 8⅝	7⅞– 8⅝
Green Seal	8¼– 8¾	8¼– 8¾	8¼– 8¾	8⅝– 8⅞	8½– 8⅞	8½– 8⅞	8½– 8⅞	8½– 8⅞
White Seal	9 – 9¼	9 – 9¼	9 – 9¼	9⅛– 9⅜	9¼– 9⅜	9¼– 9⅜	9¼– 9⅜	9¼– 9⅜
French:								
Red Seal	8¼– 8½	8¼– 8½	8¼– 8½	8⅝– 8⅝	8⅝– 8⅝	8⅝– 8⅝	8⅝– 8⅝	8⅝– 8⅝
Green Seal	10½–10¾	10½–10¾	10½–10¾	10⅝–10⅝	10⅝–10⅝	10⅝–10⅝	10⅝–10⅝	10⅝–10⅝
American process	5½– 6½	5½– 6½	5½– 6½	5½– 6½	5½– 6½	5½– 6½	5½– 6½	5½– 6½
French process:								
Red Seal	7 – 7½	7 – 7½	7 – 7½	7 – 7½	7 – 7½	7 – 7½	7 – 7½	7 – 7½
Green Seal	7½– 7¾	7½– 7¾	7½– 7¾	7½– 7¾	7½– 7¾	7½– 7¾	7½– 7¾	7½– 7¾
White Seal	8 – 8¼	8 – 8¼	8 – 8¼	8 – 8¼	8 – 8¼	8 – 8¼	8 – 8¼	8 – 8¼

[1] French process.

Zinc oxide and pigments, prices per pound wholesale New York, spot—Continued.

Kind or grade.	January, 1914.	April, 1914.	July, 1914.	October, 1914.	January, 1915.	April, 1915.	July, 1915.	October, 1915.
German:[1]	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Red Seal	6¾	6¾	6¾	6¾	(2)	(2)	(2)	(2)
Green Seal	7¾	7¾	7¾	7¾	(2)	(2)	(2)	(2)
White Seal	8½	8½	8½	8½	(2)	(2)	(2)	(2)
French:								
Red Seal	8¾	8¾	8¾	8¾	(2)	(2)	(2)	(2)
Green Seal	10¾	10¾	10¾	10¾	(2)	(2)	(2)	(2)
American process	5½	5½	5½	5½	5½	5½	7½– 8½	7½– 8½
French process:								
Red Seal	6½	6½	6½	6½	7	10½	25	30
Green Seal	7	7	7	7	7½	10½	25½	30½
White Seal	7½	7½	7½	7½	8	11½	26	31

Kinds or grades.	January, 1916.	April, 1916.	July, 1916.	October, 1916.	January, 1917.	April, 1917.	July, 1917.	October, 1917.
German:[1]	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Red Seal	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Green Seal	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
White Seal	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
French:								
Red Seal	(2)	26 –26½	16 –18	16 –18	16 –18	16 –18	16 –18	16 –18
Green Seal	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
American process	8½– 8½	8½– 8½	9¼– 9½	9¼– 9½	9¼– 9½	9¼–10	10¼–10½	10¼–10¼
French process:								
Red Seal	16	24 –24½	16 –16½	16 –16½	17½–17½	15 –15½	15 –15½	14 –14½
Green Seal	16½	24½–24½	16½–16½	16½–16½	18 –18½	15½–15½	15½–15½	14½–14½
White Seal	17	25 –25½	17 –17½	17 –17½	18½–18½	16 –16½	16 –16½	15 –15½

Kinds or grades.	January, 1918.	April, 1918.	July, 1918.	October, 1918.	January, 1919.	April, 1919.
French:	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Red Seal	13 –13½	13 –13½	13 –14½	13 –13½	12 –12½	9½
Green Seal	13½–13½	13½–13½	13½–15½	13½–13½	12½–12½	10½
White Seal	14 –14½	14 –14½	14 –17	14 –14½	12½–12½	11½
American process:						
Standard	10 –10¼	10 –10¼	10 –11½	10 –10½	.....	.....
Sterling	9¾–10	9¾–10	9¾–10	9¾–10	.....	.....
Superior	9¼– 9½	9¼– 9½	9¼– 9½	9¼– 9½	.....	.....
Lehigh	9 – 9¼	9 – 9¼	9 – 9¼	9 – 9¼	.....	.....
No. 1 Puritan	.....	10	10	.....	.....	.....
No. 2 Puritan	.....	9	9	.....	.....	.....

[1] French process.

[2] Nominal.

Zinc, oxide, and pigments—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	87	Colors and paints, including lakes, whether dry or mixed, or ground with water or oil, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
		Zinc, oxide of:	
1883	90	Dry	1½ cents per pound
1883	91	Ground in oil	1½ cents per pound
1890	60	Zinc, oxide of, and white paint containing zinc, but not containing lead:	
		Dry	1½ cents per pound.
		Ground in oil	1½ cents per pound.
1890	61	All other paints and colors, whether dry or mixed, or ground in water or oil, including lakes, crayons, smalts, and frostings, not specially provided for in this act, and artists' colors of all kinds, in tubes or otherwise.	25 per cent ad valorem.
1894	47	Zinc, oxide of, and white paint or pigment containing zinc, dry or ground in oil.	1 cent per pound.
1894	48	All other paints, colors, and pigments, whether dry or mixed, or ground in water or oil, or other solutions, including all colors in tubes, lakes, crayons, smalts, and frostings, and not specially provided for in this act.	25 per cent ad valorem.
1897	57	Zinc, oxide of, and white paint or pigment containing zinc, but not containing lead:	
		Dry	1 cent per pound.
		Ground in oil	1¼ cents per pound.
		Sulfid of zinc white, or white sulphide of zinc	1½ cents per pound.
		Chloride of zinc and sulphate of zinc	1 cent per pound.
1897	58	All paints, colors, pigments, lakes, crayons, smalts, and frostings, whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this act.	30 per cent ad valorem.
1909	55	Zinc, oxide of, and white pigment containing zinc, but not containing lead:	
		Dry	1 cent per pound.
		Ground in oil	1¼ cents per pound.
		Sulfid of zinc white, or white sulphide of zinc	1½ cents per pound.
		Chloride of zinc and sulphate of zinc	1 cent per pound.
1909	56	All paints, colors, pigments, stains, lakes, crayons, including charcoal crayons or fusians, smalts and frostings, whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this section.	30 per cent ad valorem.
		All glazes, fluxes, enamels, and colors used only in the manufacture of ceramic, enameled, and glass articles.	Do.
1913	61	Zinc, oxide of, and pigments containing zinc but not containing more than 5 per cent of lead, ground dry.	10 per cent ad valorem.
		When ground in or mixed with oil or water, lithopone, and white sulphide of zinc.	15 per cent ad valorem.
1913	63	Enamel paints, and all paints, colors, pigments, stains, crayons, including charcoal crayons or fusians, smalts, and frostings, and all ceramic and glass fluxes, glazes, enamels, and colors, whether crude, dry, mixed, or ground with water or oil or with solutions other than oil, not specially provided for in this section.	Do.

Court and Treasury Decisions.

Lithopone (sometimes called lithophone and lithofone) was held dutiable as "white paint, containing zinc, but not containing lead" under paragraph 60 of the act of 1890, rather than as "all other paints and colors, whether dry or mixed" under paragraph 61. (Gabriel *v.* U. S., 65 Fed., 422; G. A. 2962; T. D. 15862.)

That classification was continued under paragraph 57 of the act of 1897 as against the provision for sulphide of zinc in the same paragraph. (United States *v.* Gabriel, 97 Fed., 934.) In a later decision merchandise like that in United States *v.* Gabriel, composed of 70 per cent of sulphate of barytes and 30 per cent sulphide of zinc, and known as "lithofone" and as "sulphide of zinc, white," whether dried or ground in oil, was held dutiable as "sulphide of zinc, white, and not as white paint or pigment containing zinc, but not containing

lead." (Gabriel *v.* U. S., 123 Fed., 296, affirming 114 Fed., 401, which affirmed G. A. 4707, T. D. 22217; G. A. 5403, T. D. 24615. Other decisions are G. A. 2962, T. D. 15862, T. D. 15552; G. A. 1319, T. D. 12670; G. A. 1189, T. D. 12451; G. A. 1175, T. D. 12437.)

Charlton white, composed of sulphate of barium with a large proportion of zinc sulphide and a small percentage of zinc oxide, was held dutiable as white paint containing zinc, under paragraph 48 of the act of 1894. (G. A. 3343, T. D. 16824.)

Oxide of zinc powder, containing from 1.05 to 3.7 per cent of lead, was held to contain too insignificant a percentage of lead to make the article dutiable as a lead product, and accordingly was held dutiable under paragraph 60 of the act of 1890 as oxide of zinc not containing lead. (G. A. 2007, T. D. 13813.)

Chinese white in small cakes were held dutiable as oxide of zinc under paragraph 47 of the act of 1894 and not as artists' colors in cakes under paragraph 48. (G. A. 3353, T. D. 16834.) But similar merchandise ground in water was held by the Treasury Department not to come within the provision in paragraph 47 of that act for oxide of zinc, dried or ground in oil. (Dept. Order, T. D. 17582.)

White paint containing 59.23 per cent of zinc oxide and no lead was held not dutiable as white paint containing lead under paragraph 55 of the act of 1897. (Abstract 5654, T. D. 25233.)

Zinc yellow, classified under paragraph 54 of the act of 1913 was found upon analysis to be zinc and potassium chromates and dutiable accordingly under paragraph 61. (Abstract 37062, T. D. 35000.)

Zinc yellow crushed, found to consist of a pigment containing zinc, was held dutiable under the first provision of paragraph 61 of the act of 1913. (Abstract 36769, T. D. 34871.)

Enamel white paint containing zinc, but not lead, and ground in oil, with varnish added as a gloss, varnish in chief value, was held dutiable under paragraph 57 of the act of 1897 as white paint containing zinc but not containing lead ground in oil, rather than as paints ground with solutions other than oil or as varnishes. (Pomeroy *v.* U. S., 126 Fed., 583; United States *v.* Bird, 167 Fed., 319, affirming T. D. 29008, which reversed G. A. 6449, T. D. 27633.)

Enamel white, shown by analyses to contain from 58 to 63 per cent of oil, turpentine, and gum varnish, was held dutiable under paragraph 51 of the act of 1909 as "enamel paint made with varnish" rather than as "zinc, oxide of, and white pigment containing zinc * * * ground in oil" under paragraph 55 of that act. (G. A. 7356, T. D. 32453.)

Enamel paints and colors classified as chemical compounds under paragraph 17 of the act of 1913 were held dutiable as colors or paints under paragraph 63 of that act. (Abstracts 41301, 41235, 38658, 38225.)

Enamel paint was held dutiable under paragraph 55 of the act of 1909. (Abstract 36965, T. D. 34969.)

Enamel white found to contain oil and turpentine as well as varnish gum was held properly classified under paragraph 51 of the act of 1909. (Abstract 33674, T. D. 33763.)

Enamel white assessed as enamel paint made with varnish under paragraph 51 of the act of 1909 was held dutiable under paragraph 56 of that act as claimed. (Abstract 33594, T. D. 33738.)

Veluvine white was held dutiable as enamel paint under paragraph 56 of the act of 1909 and not as enamel paints made with varnish, nor as a pigment under that act. (G. A. 7324, T. D. 32243; Abstract 31546, T. D. 33263.)

Merchandise classified as a chemical salt under paragraph 3 of the act of 1909 was held dutiable as *white sulphide of zinc* under paragraph 55 of that act. (Abstract 25977, T. D. 31727.)

Chromate of zinc without lead or bichromate of potash or soda was held not dutiable as a chrome color in which lead and bichromate of potash or soda were component parts under the act of 1894. (G. A. 3896, T. D. 18139.)

MISCELLANEOUS.

IGNEOUS CONCENTRATE—CONCENTRATING SMELTING.

The introduction of igneous concentration (concentrating smelting, etc.) of ores of too low a grade to smelt or too complex to separate by mechanical methods has introduced a new product whose classification is difficult. It is strictly a leaded zinc oxide, since it consists largely of zinc oxide with varying amounts of lead as basic sulphate and since it is prepared by processes almost identical with those used for making the pigment. However, the igneous concentrate is valueless as a pigment or for any of the purposes that the older product is used for. It is only used as a source of lead, zinc, and whatever other metals—notably silver—it may contain. The color ranges from gray to red or brown; no effort is made to secure uniformity, as it is an unfinished product.

Concentrating smelting is merely a means of concentrating the metallic contents of low-grade lead-zinc ores. The Wetherill grate is frequently used as in the making of pigment oxide, especially for fine material. Lump ores were treated in Colorado in a blast furnace but are now generally treated like the fine material in a reverberatory furnace that closely resembles the Wetherill grate, although more recent practice leans toward dispensing with the blast from below, and uses a solid bottom on the hearth. Ores containing copper along with lead and zinc may be smelted in a reverberatory at a high temperature. The lead and zinc are volatilized as far as possible and the copper and gold, together with as much of the silver as does not go off in the fume, are collected in a low-grade matte. The fume is collected in bag houses or may be electrolytically precipitated (Cottrell process).

Treatment of igneous concentrate is usually leaching with acid to remove the zinc. The residue of lead and silver is sold to a lead smelter. The solution may be either electrolyzed for the production of electrolytic spelter or used as a source of zinc sulphate (crystals or in making lithopone).

The further treatment of this fume is not always done at the concentration works, so it already is an article of commerce. So far as known, none of it has been imported from foreign countries as yet. Although it is zinc oxide in large part, it is probable that it would be classed as ore at the port of entry because of its use only as a source of the metals contained, in spite of the fact that it is not a natural product.

Similar material was made from lead blast-furnace slags when zinc prices were at the higher levels. This involves another tariff

problem, but of a different sort. These slags are made in part from ores too low in zinc to pay an import tax (less than 10 per cent). The recovery of zinc in this form is now negligible in amount but an increase may warrant investigation.

ZINC YELLOW.

(Chromate of zinc, 3 $ZnCrO_4.K_2Cr_2O_7$.)

Zinc yellow resembles lead chromate in many of its properties and in appearance. It is a comparatively new pigment, having come into fairly common use only since 1905. It is used in mixed paints and paints generally on account of its alleged property of preventing rust and as a priming coat for steel. It is used in fairly large quantities for making zinc green.

Chromate of zinc, or "citron yellow," as it is sometimes called, is not a satisfactory outdoor paint because it is partly soluble in water and is, therefore, streaked by rain. It is highly satisfactory for indoor work, especially in flat wall paints. Much more delicate shades can be obtained than when lead chromate is employed and it is not subject to the darkening action inherent to lead paints when exposed to sulphur gases. However, it has less hiding power than the lead pigment and its tinctorial strength is weaker.

The process of manufacture varies. It may be prepared from zinc oxide by boiling that pigment in a solution of bichromate for several hours, after which it is filtered and washed slightly before drying, or it may be prepared by precipitation from a hot neutral solution of zinc sulphate by means of chromate (K_2CrO_4).

GREEN ZINC PIGMENTS.

The term "zinc green" is ordinarily applied only to a mixture of zinc yellow and Prussian blue (generally with more or less inert bases or fillers), whereas "Rinmann's green," which is a mixture of zinc oxide and cobaltous oxide, is rarely if ever called zinc green. The latter, however, is not an important pigment, being neither very bright nor having any considerable covering power although it is extremely insensitive to outside agencies and permanent. Zinc green is more expensive than the similar color made with lead chromate and is subject to the same comparisons as the basic ingredients. It is largely used for interior decorative purposes and for making flat wall paints. It is also used as a coach color, for which purpose it is highly satisfactory, as the varnish coats protect it from the weather.

ENAMEL PAINTS.

[Extract from brief of J. A. & W. Bird & Co., tariff hearings, H. R., 1913, p. 314.]

* * * Enamel paints as a group have a zinc oxide base and usually are ground in oil and varnish added to impart a gloss, or the zinc oxide may be ground in varnish itself. * * * Under the Dingley Tariff Act there was no economic provision for these paints as such, and they were assessed by collectors of customs under the general "basket clause" paint provision as "paints not otherwise provided for." The courts, however, on two different occasions held white enamel paints to be otherwise specially provided for under the more exact descriptive language found in paragraph 57 of the act of 1897 as "Zinc, oxide of, and white paint or pigment containing zinc, but not containing lead, ground in oil, one and three-quarters cents per pound."

The view adopted by the Federal courts was that the merchandise was in fact a white paint containing zinc, etc. * * * and that the addition of varnish did not * * * change the character of the mixture as a paint. * * *

Enamel paint is largely a specialized article, the demand for which has been worked up largely in the past decade. It is used where enamel surface is especially desired, as in painting golf balls, bathtubs, and the like. During the latter part of the lifetime of the Dingley Act, the importations, while not on an extensive scale, were sufficiently large to yield considerable revenue to the Government. No statistical figures are available of the volume of importations under the old law, nor, as far as we are aware, none are available now showing the total importations. It appears, however, from statistics published by the Department of Commerce and Labor that from August 5, 1909, the date of the Payne-Aldrich Act, to June 30, 1910, 3,334.50 gallons of enamel paints, valued at $6,485, were entered for consumption, yielding, at 35 per cent, Government revenue of only $2,269.75.

For the year ending June 30, 1911, 4,584.50 gallons, valued at $8,782.88, were entered in the same way, upon which duties amounting to $3,074.01 were collected. The amount of revenue, under present conditions is thus seen to be inconsiderable at best. Under existing conditions, handicapped by the present extensive duty, we can not compete with the domestic article which is able to undersell us regularly With a reasonable tariff rate * * * we could get our fair share of the business * * * and incidentally insure a larger Government revenue from this source. * * *

* * * the tariff rate to yield a satisfactory revenue should under no conditions exceed 20 per cent ad valorem. * * *

The present provision is for "enamel paints made with varnish" * * *. Inasmuch as many varieties of enamel paints are either made with varnish or contain varnish as an ingredient, enamel paints take one rate or the other, according as they are shown to be made with or without varnish."

In order to avoid the ambiguity of the 1909 law, the following wording was proposed:

Zinc, oxide of, paint or pigment containing zinc but not containing lead, dry, — per pound; ground in oil, — per pound.

MANUFACTURE OF ZINC OXIDE IN ITALY.[1]

Leaded zinc oxide is made in Italy direct from the ore of the Monteponi mines in Sardinia. The early development of the industry was handicapped by the special Sardinian conditions. Coal is poor and costly, so the Wetherill grate, which requires 1 to 1.5 tons of good anthracite coal to 1 ton of ore and which has proved so thoroughly satisfactory in the United States, was not adapted to the Italian conditions. The process finally developed makes use of a converter instead of the Wetherill grate. Zinc ore mixed with lean coal is reduced in the converter, which is lined with refractory material and equipped with tuyeres like the vessels used for copper or iron smelting. The vapors from the converter pass into a combustion chamber, situated directly over the converter, in which the carbon monoxide and zinc vapor are burned before entering the flue system and thence to the bag house. The fuel used is a low-grade anthracite from neighboring mines. As it contains from 16 to 20 per cent of ash, serious trouble is experienced in keeping this ash out of the product. A coal-washing plant is now (1917) being installed.

The operation is now conducted at Scalo, Sardinia (near Monteponi). The first unit of the plant was put in operation in 1914; the second section in 1917. Each section consists of five furnaces. The total production is about 13,000,000 pounds. A production of

[1] Abstract from paper by F. Sartori. Resoconti delle riunioni dell' Associazone mineraria sarda. Dec., 1917. (Eng. Min. Jl., 106 (1918), p. 742.

3,500,000 pounds was expected from the enlarged plant in 1917, but was not attained on account an of inadequate supply of fuel. The product contains about 8 per cent lead.

At first the Monteponi oxide was regarded suspiciously in the market, owing to the fact that, like practically all direct process oxides, it is not quite so white as the product obtained by burning spelter and because it was made by a new process. However, the trade soon discovered that the paints prepared from it were excellent, the oxide being of extremely fine character and capable of perfect mixture with oil without grinding or classifying.

STATEMENTS OF PRODUCERS.

[Krebs Pigment & Chemical Co. (H. J. Krebs, president). Tariff Schedule (1913) p. 142. Abstract].

We import a large tonnage of barytes—equal to our output of lithopone * * *; this finished product (lithopone) can be imported with nearly the same outlay for freight as we pay on this one article of crude material, barytes. This barium sulphate, which constitutes 70 per cent of lithopone, pays 10 per cent when imported in the finished state, while crude barytes pays 15 per cent. This constitutes a bonus on imported lithopone.

* * * Our cost of lithopone (not taking interest or invested capital into consideration) during this period (four years) averages 3⅛ cents; and under the proposed tariff schedule (10 per cent ad valorem) the Europeans will be able to import and sell this product one-half below this cost.

* * * Germany has abundant supplies both of barytes and zinc, and is able to manufacture (lithopone) at a nominal cost * * *.

* * * There may be good reasons for assigning 10 per cent ad valorem as the rate of zinc oxide which is manufactured in very large quantities and is, comparatively speaking, simple to manufacture. But it is evidently due to misconception that sulphide of zinc and lithopone are placed in the same paragraph and class. These two products are of much smaller volume (sic) and require a more complicated process * * *.

* * * We could not meet German prices if we did not get 30 per cent ad valorem. * * * we might be able to hold our own if we were afforded 25 per cent. Below this limit I do not see how lithopone business can exist.

Further statement from same authority:

Detailed cost figures were submitted showing cost of manufacture in years 1902–1912. The average total costs were in the neighborhood of 3 cents a pound, including 5 per cent interest and depreciation. About one-third of the cost was for zinc, while the total cost of all raw materials was nearly 60 per cent of the cost of the product.

The above applies, evidently, to the manufacture from spelter. Since lithopone is now largely made from secondary material containing zinc, the cost of the zinc is probably much reduced.

LITHOPONE.

(See paragraph 10.)

ZINC COMPOUNDS.

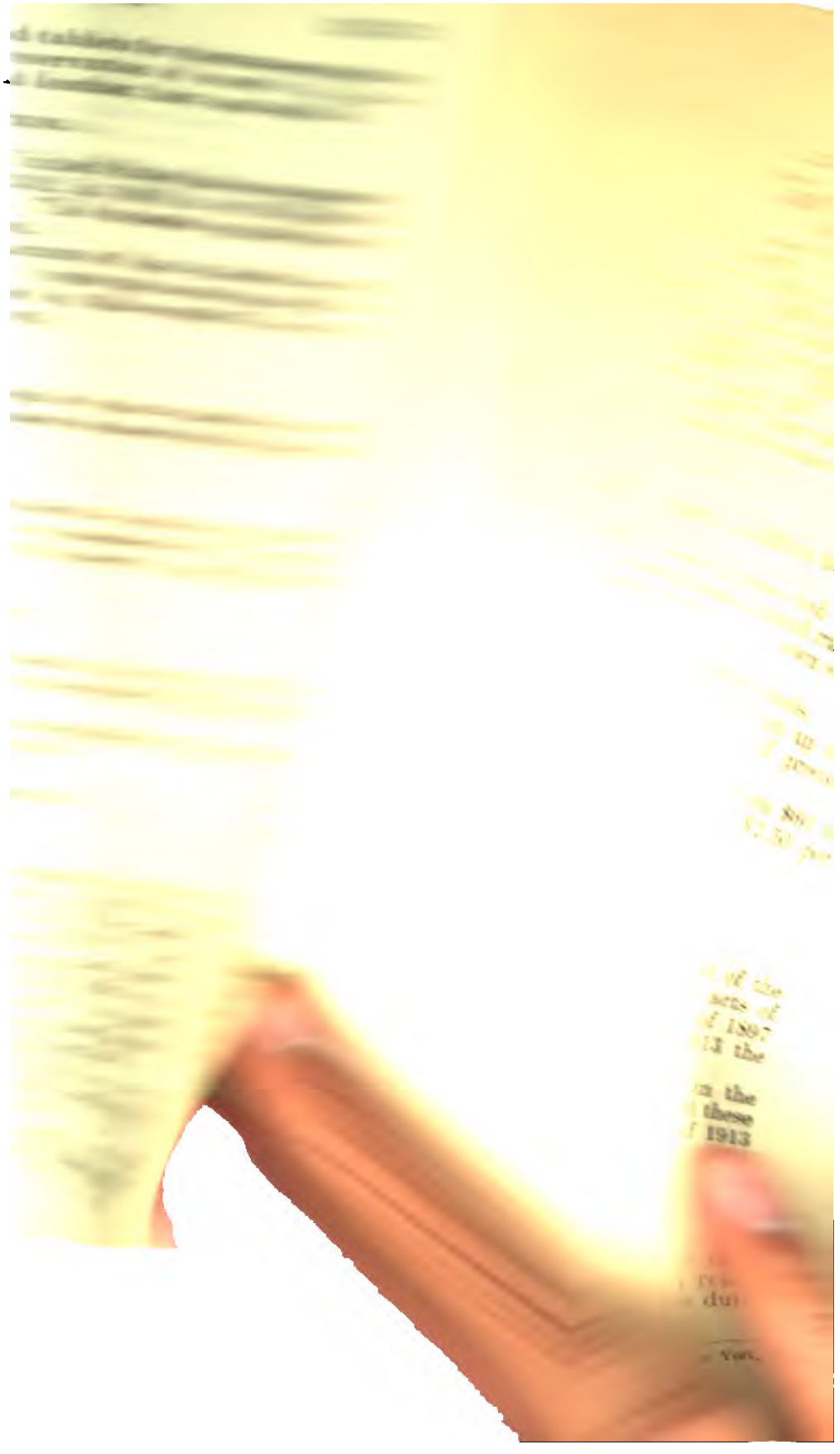
ZINC CHLORIDE.

[Par. 62, act of 1913; ½ cent per pound.]

SUMMARY.

DESCRIPTION.

Zinc chloride is a chemical compound composed of 47.75 per cent of zinc and 52.25 per cent of chlorine. It is a white to grayish-white solid, and is sold in solution, as a powder, in porcelain-like



IMPORTANT USES.

The large use of zinc chloride is for the preservation of wood. It is usually used in combination with creosote or wood tar oil. About 65 per cent of the zinc chloride produced is used for this purpose.

Zinc chloride is used as an antiseptic in cotton sizing and incidentally increases the weight of the yarn.

It is a powerful caustic, distinguished by its property of burning deep instead of burning sidewise.

In dilute solutions zinc chloride is used as an astringent, an antiseptic, disinfectant, and deodorant

A solution of zinc ammonium chloride is used as a flux in soldering, for the purpose of removing the oxide from the surface to be soldered.

It is used in the chemical laboratory as an analytical, dehydrating, and condensing agent. It is also used in the synthesis of many organic compounds.

Zinc chloride is used to dissolve casein and the solutions are used in the manufacture of artificial silk and hair.

It is used in the manufacture of artificial leather to gelatinize and cement the sheets of paper.

RAW MATERIALS.

The basic raw material for the manufacture of zinc chloride is zinc-bearing ores or scrap zinc. These are converted into zinc chloride usually by means of hydrochloric acid. The use of roasted zinc ores and hydrochloric acid is probably the most common.

The United States is the largest single producer of zinc in the world, which assures an adequate supply of the basic raw material in the manufacture of zinc chloride. Hydrochloric acid is a by-product of many processes and is produced in large quantities in this country.

PROCESS OF MANUFACTURE.

Part of the zinc chloride produced in this country is a by-product in the galvanizing of sheet iron. The zinc chloride is formed by the combination of the molten zinc with the ammonium chloride, which is used as a flux and covers the surface of the molten zinc.

The most simple method of preparing zinc chloride consists in dissolving metallic zinc in hydrochloric acid. The impurities are precipitated by means of bleaching powder and soda ash. A clear solution of zinc chloride is then obtained either by filtering or by settling and then siphoning off the clear supernatant liquid. This is the method usually employed using zinc spelter.

Zinc chloride can be made by dissolving roasted zinc ore in hydrochloric acid. This seems to be more preferable and a cheaper method than using zinc which has already been prepared from the ore.

The solid zinc chloride is prepared by evaporating the solution of zinc chloride. The evaporation is continued up to about 240°, when hydrochloric acid is added and the mass is allowed to cool and solidify. The anhydrous chloride is prepared by dissolving solid zinc chloride in hydrochloric acid; the solution is then evaporated in a current of hydrochloric acid gas until the mass solidifies.

The solid chloride is fused in a current of hydrochloric acid gas and then allowed to solidify. It now must be packed in suitable containers to keep it from absorbing moisture.

The solution of zinc chloride, the solid chloride, and the anhydrous chloride can be purchased on the market. It is usually more satisfactory to purchase the solid variety and dissolve it to the desired strength rather than to buy the solution unless the percentage content of zinc chloride is guaranteed.

Zinc chloride [1]*—Production in United States—Official source.*

[From Federal Census.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1899	9,511,909	$353,900	1909	25,054,213	$472,302
1904	11,579,546	201,771	1914	40,786,886	1,130,959

[1] Listed as "Zinc salts"; not listed as "Zinc chloride."

Zinc, chloride of—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1907	1 cent per pound	1,399,517	$38,236	$13,995	$0.027	36.60
1908	do	1,172,134	34,107	11,721	.029	34.37
1909	do	1,348,678	35,302	13,302	.026	38.20
1910	do	1,201,440	31,644	12,014	.026	37.97
1911	do	1,311,185	34,978	13,011	.027	37.20
1912	do	1,182,441	33,133	11,824	.028	35.69
1913	do	1,252,319	37,078	12,523	.030	33.78
1914	do	160,103	4,547	1,601	.028	35.21
1914	½ cent per pound	629,193	18,956	3,145	.030	16.60
1915	do	194,250	5,805	971	.029	16.73
1916	do	12,643	463	63	.036	13.65
1917	do	6,216	629	31	.101	4.94
1918	do	197,570	15,381	987	.077	6.42
Calendar year:						
1919	do	2,016	192	10	.095	5.25
1920 [1]	do	78,212	7,560	391	.097	5.17

[1] Six months, Jan. 1, 1920, to July 1, 1920.

Zinc chloride—Prices, cents per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.	Lowest.	Highest.
1912	4 - 4½	4½ - 4⅝	4½ - 4⅝	4½ - 4⅝	4	4½
1913	4½ - 4⅝	4½ - 4⅝	4½ - 4⅝	4½ - 4⅝	4½	4⅝
1914	4½ - 4⅝	4½ - 4⅝	4½ - 4⅝	4½ - 4⅝	4½	4⅝
1915	4½ - 4⅝	4½ - 4⅝	8 - 8½	8 - 8½	4½	8½
1916	8 - 8½	14 -15	13 -14	13 -14	8	14
1917	13 -14	15 -15½	16 -17	16 -17	13	17
1918	10½-11½	10½-11½	15 -15½	15 -15½	10½	15½
1919	15 -15½	13½-14	8 -10	12 -13½	8	15½
1920	13 -14	13½-14	13½-14	13½-14	13	14

Zinc chloride—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	57	* * * chloride of zinc	1 cent per pound.
1909	55	.....do	Do.
1913	62	Zinc, chloride of * * *	½ cent per pound.

Zinc chloride—Court and Treasury decisions.

Chloride of zinc in solution was held dutiable as a chemical compound or salt and not exempt from duty as an acid used for medicinal, chemical, or manufacturing purposes, n. s. p. f. under the act of 1890. (G. A. 1575 (T. D. 13070).)

Consumption of zinc chloride as wood preservative.[1]

Year.	Wood treated.[2]	Zinc chloride used.	Per cent of production.	Production of zinc chloride.[3]
	Cubic feet.	*Pounds.*		*Pounds.*
1909	24,476,386	16,215,107	64.7	25,054,213
1910	28,200,157	16,802,532	.....	.....
1911	29,501,065	16,359,797	.....	.....
1912	28,831,184	20,751,711	.....	.....
1913	36,693,238	26,466,803	.....	.....
1914	51,343,035	27,212,359	66.7	40,786,886
1915	56,144,007	33,269,604	.....	.....
1916	45,732,979	26,746,577	.....	.....

[1] Quantity of Wood Treated and Preservatives Used in the United States in 1916, by R. K. Helphenstine, jr., U. S. Forest Service.
[2] Principally crossties, about 90 per cent.
[3] Federal Census.

ZINC SULPHATE.

(Par. 62, Act of 1913, ½ cent per pound.)

General Information.

DESCRIPTION.

Zinc sulphate or white vitriol occurs in commerce as colorless transparent crystals or as a granular crystalline powder. It has the chemical formula $ZnSO_4{-}7H_2O$ and contains 22.7 per cent of metallic zinc, 33.4 per cent of sulphuric acid (SO_4) and 43.9 per cent of water. The crystals of zinc sulphate melt on heating and lose all of their water of crystallization at about 300° C. On further heating to redness the zinc sulphate is decomposed, leaving a residue of zinc oxide. A product for pharmaceutical purposes should "contain not less than 55.86 per cent nor more than 58.65 per cent of anhydrous zinc sulphate, corresponding to not less than 99.5 per cent of the crystallized salt."

USES.

Zinc sulphate is used in the manufacture of zinc pigments, especially lithopone; for preserving and clarifying glue solutions; as a disinfectant; as a mordant in the dyeing and printing of textiles; as an as-

tringent and emetic in medicine; and to some extent in preserving wood and hides. It is also used in electroplating and is the intermediate salt produced in the electrolytic production of zinc from zinc ores.

DOMESTIC PRODUCTION.

Statistics on the domestic production of zinc sulphate are not available.

Zinc sulphate may be produced from zinc dross, zinc scrap, or roasted zinc sulphide ores. If the zinc sulphate is to be marketed it is usually produced by treating either zinc dross or scrap zinc with sulphuric acid. The zinc sulphate produced is then crystallized from the solution. Zinc sulphate solution is produced in the electrolytic production of zinc from roasted zinc ores. The ores are roasted so as to produce primarily zinc sulphate. This is leached from the roasted ores by means of hot dilute solutions of sulphuric acid. This solution is purified and the zinc deposited by means of the electric current in suitable apparatus.

Zinc sulphate is usually produced by the manufacturers of zinc spelter from the zinc dross that is obtained in the melting of zinc. The production of zinc sulphate is closely allied with the production of metallic zinc.

Imports of zinc sulphate are not shown until 1913. They have been sporadic and with the possible exception of 1914 and 1915 they are entirely negligible.

The price of zinc sulphate has increased during the war to about three times the normal prewar price of around 2¼ cents per pound.

TARIFF HISTORY.

Zinc sulphate was first mentioned by name in the act of 1897 as dutiable at 1 cent per pound. This duty was reduced by the act of 1913 to one-half cent per pound.

Zinc, sulphate of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	1 cent per pound	52,209	$1,288.00	$522.00	$0.025	40.53
1908	do	53,845	1,994.00	538.00	.037	27.00
1909	do	38,406	1,129.00	384.00	.029	34.02
1910	do	55,923	1,709.00	559.00	.031	32.72
1911	do	45,423	2,042.00	454.00	.045	22.25
1912	do	76,890	2,298.00	768.00	.030	33.46
1913	do	23,778	817.00	237.00	.034	29.10
1914	do	765	53.00	7.00	.069	14.44
1914	½ cent per pound	107,300	2,123.00	536.00	.020	25.27
1915	do	68,940	1,027.00	344.00	.014	33.56
1917	do	28	44.00		1.571	.32
1918	do	21	35.00		1.666	.31
1919	do	221	133.00	1.10	.602	.84

Zinc sulphate, prices (wholesale) spot, New York, cents per pound.

[From Oil, Paint, and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	2½–2¾	2½ 2.6	2½–2¾	2.35–2.65	6½–7	6½–7	6 –7	5½–6	3½–4
April	2½–2¾	2½–2.6	2½–2¾	2½–2¾	6½–7	6½–7	5 –7	4 –5	3½–4¼
July	2½–2¾	2½–2¾	2.35–2.65	4½–5	6½–7	6½–7	4¼–6½	3¼–4	3½–4¼
October	2½–2¾	2½–2¾	2.35–2.65	6½–7	6½–7	6½–7	4¼–6½	3¼–3¾	3½–4¼

Zinc sulphate—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	57	Zinc, * * * sulphate of, per pound	1 cent.
1909	55	.....do	Do.
1913	62	.....do	½ cent.

PAINTS.

General Information.

INTRODUCTION.

Act of 1913: "63. Enamel paints, and all paints, colors, pigments, stains, * * * whether crude, dry, mixed, or ground with water or oil or with solutions other than oil, not specially provided for in this section, 15 per centum ad valorem, * * *; all paints, colors, and pigments commonly known as artists' paints or colors, whether in tubes, pans, cakes, or other forms, 20 per centum ad valorem."

The above provision includes all mixed paints including enamel paints and all colors and pigments, except color lakes, not elsewhere provided for in the act of 1913. Practically all of the important pigments are provided for by name or by general description in paragraphs 51 to 61, inclusive, and only a few minor ones fall within this classification.

In order that a clear understanding may be had of the relation between paints and varnishes a brief contrast of their composition is given here:

Varnishes: Spirit—Gum resin, volatile solvent. Oil—Gum resin, drying oil, thinner, drier.

Paints: Pigment, drying oil, thinner, drier.

Enamels: Pigment, gum resin, drying oil, thinner, drier.

It can be seen from the above classification that the difference between oil varnishes and mixed paints is that the varnishes contain a gum resin while paints contain a pigment instead; the other ingredients are similar. Enamels or enamel paints are a varnish containing a pigment, or are a combination of a paint and varnish. The substances used as pigments, drying oils, thinners, and driers are many and varied.

The term "stains" as used in the paint industry has two meanings. In one instance it refers to colors which in distinction from pigments have no great body or covering properties and are used simply to tint mixed paints. In another case it refers to a class of mixed paints which are thinner than ordinary house paint, used to stain wood, particularly shingles.

DESCRIPTION OF MIXED PAINTS.

House paints are mixed paints used for painting the exterior of dwellings. This is one of the most important classes of mixed paints. Prepared house paints usually contain approximately 65 parts by weight of pigment and 35 parts by weight of vehicle, which in high-grade paints is pure linseed oil with a small percentage of turpentine and drier. The pigment is generally a mixture of white lead and zinc oxide, and sometimes contains a small percentage of inert pigments, such as barytes, asbestine, silica, whiting, gypsum, or china clay. The cheaper grades contain a much larger proportion of the inert pigments.

Barn paints used in agricultural districts for painting barns and similar outbuildings are usually a cheap mixed paint composed of iron oxide pigments ground or mixed in linseed oil and then thinned with benzene.

Enamels or enamel paints consist of a pigment ground in a varnish. At first a spirit varnish (white dammar dissolved in turpentine) was used in which to grind the pigment, usually zinc oxide. Later, short oil varnishes of the copal type were used. More recently lithopone has been used instead of or with zinc oxide in the preparation of certain types of enamels. Enamel paints produced from oil varnishes are more durable for exterior purposes than those from spirit or gum varnishes. Zinc and lithopone enamels have almost entirely replaced the use of corroded white lead for interior painting. Enamel paints dry to give a gloss coating of great brilliancy and light-reflecting value.

Flat wall paints are essentially enamel paints which dry to give a flat, semiflat or matt finish, which have become very popular because of their restful effect upon the eyes. The products called Sanitary Flat Wall Paints are composed of lithopone and zinc oxide admixed, sometimes, with small percentages of inert pigments ground in a tung oil varnish and thinned with high boiling point petroleum. This produces a paint which is waterproof and washable. These flat wall paints are produced in many shades and tints. The great hiding power of lithopone makes these paints more economical, as one or two coats are sufficient to do the work which formerly required several coats of flatted white lead paint.

Factory paints cover a class of mixed paints made on a lithopone base with a vehicle of treated tung or linseed oil. These paints are generally white or light tinted and are used for the interior of factories to improve and facilitate illumination.

Cement paints are a special class of mixed paints used to decorate and render cement waterproof. They are usually composed of sublimed or corroded white lead, zinc oxide, or lithopone as a base, combined with a considerable quantity of inert pigment and ground in treated tung oil so as to produce a highly waterproof paint.

Metal paints include those composed of basic pigments (red lead, chromates, basic sulphate of lead, zinc oxide) ground in linseed oil with a small proportion of thinner and drier and used to protect iron and steel from rust. The rusting of steel and iron is due to an electrolytic action between the iron or steel and impurities which are present. This effect may be prevented by basic substances which render the iron passive to this electrolytic action. Red lead

paint is much in favor as the first or priming coat to be applied to iron and steel. Enormous quantities of these paints are used each year.

Bituminous paints, which are composed of coal tar dissolved in petroleum light oils and benzol, are used for a protective coating on cement, water pipes, and carriers which are to be placed beneath the surface of the ground. Utah gilsonite (asphalt) is dissolved in turpentine or in drying oils by the aid of heat and reduced with thinners for high grade bituminous coatings. These products are also used as baking japans on hardware and other metal manufactures. These coatings are more logically classed as varnishes as they do not contain a pigment.

Marine or antifouling paints are used to paint the bottom of ships to protect them from barnacles, which greatly reduce the speed of ships when they become attached to them. They are of two classes—one depends on using a grease or soap in the paint so that the weight of the barnacles causes them to drop off, and another depends on poisonous ingredients to kill the barnacle. This latter class has become the more important. They usually contain mercuric oxide, copper cyanide, or copper scale (oxide) as the poisonous ingredient. Zinc oxide and iron oxides generally constitute the pigment part and are mixed with a rapid drying varnish, usually shellac. Pine-tar oil and turpentine are also used to some extent.

Floor paints are a type of enamel paints designed to resist abrasion and for application on surfaces subject to constant wear. Such paints are made upon a zinc, lead, and inert pigment base which is ground in linseed oil and then mixed with a kauri gum varnish and thinned with turpentine.

Water paints, such as calcimine, consist of gypsum or whiting as the inert base and often a considerable percentage of zinc oxide, lithopone, clay, or silica and are tinted with mineral oxides. These pigments are mixed with glue or casein as binding materials and are sold in powder form ready to be mixed with water and applied. Although these water paints are widely used because of their comparative cheapness they are not washable and are not as durable as oil paints.

Artists' paints and colors consist of various pigments ground in a special grade of drying oil, such as walnut oil, which drys to a transparent colorless film. These paints are usually put up in tubes for artists' use. They constitute a small part of the paint industry.

DOMESTIC PRODUCTION.

Size of the industry.—The Census of Manufactures, 1914, shows that there were 585 establishments engaged in the manufacture of paint and pigments, with an output of $112,408,742. Of this production, about $73,000,000 was represented by paints, including those in paste form, mixed ready for use, and water paints. The production of paints mixed for use was 40,745,000 gallons valued at $41,500,000.

Production and consumption.—The domestic production of paints supplies practically the entire domestic consumption, as the value of imports in 1914 was less than 1 per cent of the value of the domestic output. Although statistics are not available, the United States is undoubtedly one of the leading producers of paints, as paint is used to a greater extent in this country than in any other civilized nation.

Exports.—The exports of ready-mixed paints in 1913 and 1914 were about 900,000 gallons, valued at over $1,000,000. The exports of ready-mixed paints in 1914 were about 1.5 per cent of the domestic production. In 1915 they decreased to about 700,000 gallons, valued at $885,000, but then steadily increased to 2,262,000 gallons, valued at about $2,700,000, in the calendar year 1919. Cuba has taken between 25 and 35 per cent of the total exports of ready-mixed paints. Exports to European countries have been comparatively small. South and Central American and Oceanic countries have been the principal consumers. As a whole, exports of mixed paints have been diversified.

Process of manufacture.[1]—The materials required in the manufacture of paints are a pigment, drying oil, thinner, and a drier for quick-drying paints.

The white pigments used in paints are basic carbonate white lead, basic sulphate white lead, zinc oxide, leaded zinc, and lithopone. Inert fillers, such as barytes, china clay, silica, and asbestine, are used along with these pigments. The colored pigments consist of natural earth colors (ocher, umber, sienna, iron oxides) and chemical pigments, such as ferro-ferricyanide blues, chromates, color lakes.

Linseed oil is the principal drying oil used and serves as the "vehicle" or pigment carrier. Other oils are used in conjunction with linseed or in place of it. Perilla oil has been used the most extensively.

The thinners used in paint are chiefly turpentine, high boiling point petroleum, benzine, and benzol. These thinners are used to reduce the paint to a suitable consistency for application.

Driers used in paints are oxides of lead and manganese added to hot linseed oil or resinates and oleates of lead and magnanese dissolved in benzine or other volatile solvent.

In the manufacture of paints the pigment is first mixed with oil in a rotary mixer or an edge runner. This mixture is then milled through revolving plates of dressed stone or steel and comes from the mill in the form of a smooth, heavy paste. The paste is stored in large tanks and removed as needed to smaller mixing tanks, where it is thinned with additional linseed oil, and thinners, driers, and tinting colors are added. After thorough mixing of the various ingredients the prepared paint is then packed in containers for shipment.

The paint factory is usually arranged so that the pigments are stored on the top floor and then work downward through the various manufacturing steps until the finished paint is packed on the lower floor for shipment. The liquids—drying oil, thinners, driers—are kept in large storage tanks in the basement of the building or outside, and transferred to the desired point through pipes by means of compressed air.

IMPORTS INTO THE UNITED STATES.

The combined imports of paints prior to the war were valued at between $500,000 and $650,000. In 1914 imports of paints were less than 1 per cent of the domestic output. During war years imports

[1] Abstracted from article on "The manufacture and use of prepared paint products," by Henry A. Gardner, in Roger's Manual of Industrial Chemistry.

declined to $135,000 in 1918. During the 1919 calendar year they were valued at $218,117.

The bulk of the imported paint has come in under the general provision "all other paints, colors, pigments, stains, n. s. p. f." Imports under this classification prior to 1914 were valued at between $400,000 and $570,000. They declined to $43,523 in 1918, and then increased slightly to $109,492 in 1919 (calendar year).

Imports of enamel paints have been small and sporadic; the maximum import was valued at $17,000 in 1914.

Imports of artists' paints or colors showed a steady growth prior to the war to over $200,000 in 1914. They then decreased to $91,220 in 1918. During the 1919 calendar year imports were valued at $103,000.

TARIFF HISTORY.

Provision was made in the act of 1890 for "artists' colors of all kinds, in tubes or otherwise," at 25 per cent ad valorem, and for "artists' water-color paints," dutiable at 30 per cent ad valorem. The act of 1894 provided for "all colors in tubes," dutiable at 25 per cent ad valorem. In the act of 1897 the provision was changed to "all paints, colors, and pigments, commonly known as artists' paints or colors, whether in tubes, pans, cakes, or other forms," and a duty of 30 per cent was imposed. This provision was repeated in the acts of 1909 and 1913 with a duty at 30 per cent and 20 per cent, respectively.

In the act of 1909 "enamel paints made with varnish" were made dutiable at 35 per cent ad valorem. The act of 1913 reduced the duty on enamel paints to 15 per cent ad valorem. All paints and colors n. s. p. f. were dutiable at 25 per cent ad valorem under the acts of 1883, 1890, and 1894; at 30 per cent under the acts of 1897 and 1909; and at 15 per cent ad valorem under the act of 1913.

Paints—Domestic production.

[From Federal Census of Manufactures, 1914.]

	1914	1909	1904	1899
Number of establishments [1]	585	588	449	419
Total cost of materials [1]	$71,588,364	$62,458,250	$46,306,183	$33,799,386
Total value of products [1]	$112,408,742	$94,572,005	$67,277,910	$50,874,995
Paints in oil	$70,582,461	$57,380,539	$41,454,124	$33,181,681
In paste form—				
White lead—				
Pounds	281,417,563	246,569,970	229,622,000	119,012,000
Value	$18,141,444	$15,234,539	$11,789,982	$6,127,960
Zinc oxide—				
Pounds	9,551,840			
Value	$730,918			
All other—		165,038,353	134,042,000	191,420,000
Pounds	129,042,658	$11,435,937	$8,892,755	$11,751,240
Value	$10,165,819			
Mixed for use—				
Gallons	40,745,563	34,278,989	22,755,018	17,437,311
Value	$41,544,280	$30,710,063	$20,771,387	$15,302,481
Water paints and calcimine:				
Dry or in paste—				
Pounds	61,904,258	47,465,715	28,457,447	14,412,653
Value	$2,055,180	$1,917,047	$936,607	$744,024
Mixed for use—				
Gallons	297,173	543,733	[2]	[2]
Value	$147,109	$64,114	[2]	[2]

[1] Includes pigments.

[2] Figures not available.

Paints, pigments, colors, and varnishes—Imports by countries (fiscal years).

Imported from—	1910	1911	1912	1913	1914	1915
Austria-Hungary	$33,620	$37,010	$42,093	$48,256	$51,284	$27,851
Belgium	38,805	56,543	112,451	108,299	147,098	40,723
France	252,578	229,335	238,446	255,610	293,498	211,227
Germany	928,327	999,479	783,884	970,497	1,059,045	756,292
Italy	51,131	49,727	38,021	69,577	58,073	74,409
Netherlands	52,457	60,619	53,423	50,719	58,296	209,886
United Kingdom	518,458	576,790	590,073	580,518	612,317	576,217
Canada	21,233	18,225	13,691	21,083	18,511	18,123
All other	18,376	17,820	33,409	39,515	27,100	44,380
Total	1,914,985	2,045,548	1,905,491	2,144,074	2,325,222	1,959,108

Imported from—	1916	1917	1918	Imported from—	1916	1917	1918
Austria-Hungary	$801	.....	.....	United Kingdom	$878,237	$654,507	$435,578
Belgium	5,750	.....	.....	Canada	79,614	73,858	101,543
France	365,439	$318,069	$192,139	All other	99,960	164,391	119,037
Germany	49,383	36,365	.....	Total	2,009,166	1,533,278	961,047
Italy	106,494	93,873	78,003				
Netherlands	423,488	192,215	34,747				

All other paints, colors, pigments, stains, smalts and frostings, crude dry, mixed or ground with water or oil or other solutions, n. s. p. f.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1910	30 per cent ad valorem.	.....	$570,679	$171,203	.....	30.00
1911	do	.....	552,716	165,814	.....	30.00
1912	do	.....	407,275	122,182	.....	30.00
1913	do	.....	450,725	135,217	.....	30.00
1914[1]	do	.....	98,175	29,452	.....	30.00
1914[2]	15 per cent ad valorem.	.....	216,890	32,533	.....	15.00
1915	do	.....	233,877	35,081	.....	15.00
1916	do	.....	172,576	25,886	.....	15.00
1917	do	.....	118,509	17,776	.....	15.00
1918	do	.....	43,523	6,528	.....	15.00
Calendar years:						
1918	do	.....	51,507	7,726	.....	15.00
1919	do	548,278	109,492	16,424	$0.199	15.00

Enamel paints—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Gallons.*				*Per cent.*
1910	35 per cent ad valorem.	3,334	$6,485.00	$2,269.00	$1.950	35.00
1911	do	4,584	8,782.00	3,074.00	1.930	35.00
		Pounds.				
1912	do	35,463	7,684.00	2,689.00	.217	35.00
1913	do	59,257	11,840.00	4,144.00	.200	35.00
1914[1]	do	7,760	1,464.00	512.00	.189	35.00
1914[2]	15 per cent ad valorem.	88,413	15,852.00	2,377.80	.179	15.00
1915	do	86,078	6,504.00	975.60	.076	15.00
1916	do	54,546	8,987.00	1,348.05	.165	15.00
1917	do	118,571	13,902.00	2,085.30	.118	15.00
1918	do	2,470	336.00	50.00	.136	15.00
Calendar years:						
1918	do	1,841	525.00	79.00	.285	15.00
1919	do	7,313	5,638.00	846.00	.770	15.00

[1] From July 1 to Oct. 3, 1913, under the act of 1909 listed as "Enamel paint made with varnish."
[2] From Oct. 4, 1913, to June 30, 1914.

Artists' paints or colors, etc.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				
1910	30 per cent ad valorem.		$79,882	$23,964		30.00
1911	do		80,130	24,039		30.00
1912	do		104,939	31,481		
1913	do		136,893	41,068		
1914	do		41,355	12,406		
1914	20 per cent ad valorem.		169,959	33,991		20.00
1915	do		186,728	37,345		
1916	do		129,653	25,930		
1917	do		163,958	32,791		
1918	do		91,220	18,244		
Calendar years:						
1918	do		85,207	17,041		
1919	do	99,993	102,987	20,597	$1.02	20.00

Combined imports of enamel paints, artists' paints or colors, and all other paints, colors, pigments, stains, smalts, and frostings, n. s. p. f.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:						
1910			$657,046	$197,436		
1911			641,628	192,927		
1912			519,898	156,352		
1913			599,458	180,429		
1914			543,695	111,272		
1915			427,109	73,402		
1916			311,216	53,164		
1917			296,369	52,652		
1918			135,079	24,822		
Calendar years:						
1918			137,239	24,846		
1919			218,117	37,867		

Paints, pigments, colors, and varnishes: Ready-mixed paints [1]*—Domestic exports (fiscal years).*

Exported to—	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
United Kingdom	35,478	$43,380	48,175	$61,822	29,746	$36,724
Canada	147,985	141,152	85,462	87,868	53,655	60,113
Panama	35,375	38,557	56,196	65,477	37,444	42,445
Mexico	84,722	109,091	43,409	53,869	29,001	36,558
Cuba	218,454	248,915	184,264	223,459	198,811	218,555
Argentina	76,940	125,722	46,812	78,024	37,402	63,749
Brazil	40,461	66,224	29,125	44,679	17,240	26,533
Chile	17,464	29,412	16,051	26,829	13,146	17,101
Colombia	7,565	10,855	17,148	23,416	14,174	19,231
Uruguay	10,786	19,693	11,377	18,750	13,468	21,399
Venezuela	8,463	11,236	14,459	15,348	11,202	11,563
China	15,178	20,286	9,085	13,263	12,600	13,973
Japan	23,398	28,231	11,670	14,919	16,149	20,108
Australia	65,881	88,622	95,572	118,403	57,155	82,320
New Zealand	13,887	20,647	26,198	38,289	25,965	36,207
Philippine Islands	29,193	38,279	18,829	29,181	19,772	28,391
All other	130,715	171,278	139,078	182,739	116,564	149,730
Total	961,945	1,211,580	852,910	1,096,335	703,494	884,700

[1] Included in "All other paints, pigments, etc.," prior to 1913.

Paints, pigments, colors, and varnishes: Ready-mixed paints—Domestic exports (fiscal years)—Continued.

Exported to—	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
United Kingdom	18,529	$31,635	5,272	$9,748	1,054	$3,306
Canada	76,101	76,274	107,301	121,977	126,483	172,767
Panama	69,491	74,976	26,613	57,453	18,954	29,913
Mexico	31,847	40,259	58,701	90,548	94,418	149,757
Cuba	283,698	350,956	307,995	411,456	423,451	596,605
Argentina	71,149	111,790	63,546	135,492	98,604	196,002
Brazil	36,881	55,459	49,210	85,393	48,716	98,018
Chile	24,963	35,250	36,573	55,912	71,743	117,017
Colombia	17,268	26,863	27,304	45,691	13,474	26,556
Uruguay	14,430	22,603	14,382	32,612	18,510	33,634
Venezuela	20,038	26,974	22,151	33,575	16,150	25,032
China	41,488	37,255	69,761	90,289	62,913	82,432
Japan	12,075	17,210	22,589	34,620	24,072	36,343
Australia	63,549	84,880	56,685	77,460	84,286	135,896
New Zealand	31,201	42,030	23,976	39,778	45,274	87,625
Philippine Islands	58,177	70,846	37,393	52,426	78,212	118,376
All other	224,562	277,496	276,600	380,963	293,158	439,053
Total	1,095,417	1,382,756	1,216,052	1,755,393	1,519,472	2,398,332

Ready-mixed paints—Domestic exports (calendar years).

Exported to—	1918		1919	
	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*	
Canada	112,105	$186,747	139,132	$225,880
Mexico	95,883	173,990	145,890	311,749
Newfoundland and Labrador	41,503	81,948	50,272	108,731
Cuba	454,183	674,076	534,079	888,121
Argentina	139,277	294,747	165,449	455,325
Brazil	87,303	152,174	132,953	300,155
Chile	88,524	179,524	65,598	154,992
Japan	37,823	55,331	23,127	55,482
Australia	113,623	211,415	80,720	191,806
New Zealand	67,585	147,135	50,488	116,705
Philippines	92,120	152,531	120,639	255,348
All other	589,455	1,014,150	753,267	1,635,631
Total	1,919,384	3,323,768	2,261,914	4,699,925

Paints, pigments, colors, and varnishes—All other (including crayons)—Domestic exports (fiscal years).

Exported to—	1910	1911	1912	1913	1914	1915	1916	1917	1918
Belgium	$21,103	$37,820	$44,474	$6,971	$4,394	$302	.....	.....	.....
France	35,890	39,226	42,823	16,123	29,463	2,479	$40,805	$95,440	$25,834
Germany	82,465	79,927	119,315	32,351	27,757	1,593	.....	.....	.....
Italy	30,528	29,194	26,613	766	756	4,839	17,593	25,852	31,943
Netherlands	28,336	64,051	66,362	19,383	13,802	8,177	12,012	34,538	.....
United Kingdom	685,952	659,869	657,079	105,284	167,313	231,720	573,700	408,279	618,476
Canada	482,785	633,328	746,351	582,156	550,146	397,536	841,618	1,204,334	1,106,640
Panama	85,597	87,626	75,309	42,135	26,432	21,492	101,037	108,423	87,516
Mexico	209,153	236,492	241,518	90,804	35,136	28,565	57,105	130,170	169,320
Cuba	260,140	323,744	309,665	120,791	139,688	177,420	349,988	537,307	615,450
Argentina	143,337	132,826	181,035	70,700	54,896	66,583	146,113	203,581	274,024
Brazil	75,332	125,235	109,207	82,407	45,016	37,718	133,346	197,322	160,890
Chile	20,351	33,560	70,817	21,300	22,763	8,106	54,869	102,737	333,915
Uruguay	19,400	37,016	40,628	1,270	103	3,148	26,302	35,298	71,952
Japan	53,369	58,256	47,194	16,142	23,206	76,261	132,732	92,523	88,905
Australia	274,093	316,263	338,584	231,756	224,229	172,176	202,069	176,288	207,309
New Zealand	56,844	74,929	68,881	49,040	47,266	29,101	48,812	56,651	33,133
Philippine Islands	165,312	167,054	210,722	57,837	66,425	61,076	69,547	68,340	87,252
All other	362,208	467,970	467,430	250,033	301,072	196,202	451,891	936,466	960,754
Total	3,090,498	3,601,384	3,864,307	1,802,049	1,779,863	1,527,494	3,259,539	4,413,549	4,876,312

Paints, etc.—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	87	Colors and paints, * * * whether dry or mixed, or ground with water or oil, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	61	All other paints and colors, whether dry or mixed, or ground in water or oil, * * * not specially provided for in this act, and artists' colors of all kinds, in tubes or otherwise.	Do.
		All paints and colors, mixed or ground with water or solutions other than oil, and commercially known as artists' water-color paints.	30 per cent ad valorem.
1894	48	All other paints, colors, and pigments, whether dry or mixed, or ground in water or oil, or other solutions, including all colors in tubes, * * * and not specially provided for in this act.	25 per cent ad valorem.
1897	58	All paints, colors, pigments * * * whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this act.	30 per cent ad valorem.
		All paints, colors, and pigments, commonly known as artists' paints or colors, whether in tubes, pans, cakes, or other forms.	Do.
1909	56	All paints, colors, pigments, stains, * * * whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this section.	Do.
		* * * All paints, colors, and pigments, commonly known as artists' paints or colors, whether in tubes, pans, cakes, or other forms.	Do.
1909	51	* * * Enamel paints made with varnish	Do.
1913	63	Enamel paints, and all paints, colors, pigments, stains, * * * whether crude, dry, mixed, or ground with water or oil or with solutions other than oil, not specially provided for in this section.	15 per cent ad valorem.
		All paints, colors, and pigments commonly known as artists' paints or colors, whether in tubes, pans, cakes, or other forms.	20 per cent ad valorem.

Court and Treasury Decisions.

A red pigment imported for use as a color and filler and found to be an ochery earth and not commercially known as an ocher, but declared to be hematite ore, was held dutiable as a color within paragraph 48 of the act of 1894 and not exempt from duty as ocher under paragraph 566 of that act. (Vandegrift *v.* United States, 197 Fed., 265.) In later cases hematite iron ore was held to come within the provision in paragraph 121 of the act of 1897 as iron ore dutiable at 40 cents per ton. The courts declared that the merchandise was in a crude state and not usable in its condition as imported as a color. (Francklyn *v.* United States, 119 Fed., 470; Hill *v.* Francklyn, 162 Fed., 880.) In a later case, however, under the act of 1897, Collins's oxide, a hematite ore which can not be profitably smelted and which has been made unfit for smelting by a pulverizing treatment, was held to come within the provision for colors in paragraph 58 and not dutiable as iron ore. (Collins *v.* United States, 3 Ct. Cust. Appls., 83.)

Cadmium sulphide was also held dutiable under paragraph 58 of the act of 1897 as a color or pigment and not as a chemical compound or salt. (Drakenfeld *v.* United States, 2 Ct. Cust. Appls., 512.)

The provision for "colors * * * not containing quicksilver but * * * containing lead," in paragraph 54 of the act of 1897, was held more specific for colors containing lead than the provision for "colors * * * not otherwise specially provided for," in paragraph 58. (United States *v.* Marsching, 177 Fed., 593.)

There is no trade understanding that the terms "pigment" and "paint" are synonymous. A pigment is a basic material for the making of paint and is never understood as applying to a mixed paint ready for application with the brush. Veluvine white is a finished enamel paint made without varnish and therefore dutiable

as "enamel paint" under paragraph 56 of the act of 1909 rather than as "enamel paints, made with varnish," under paragraph 51, or as a pigment, under paragraph 55. (G. A. 7324, T. D. 32243.)

Oxide of chromium containing no lead or postassium bichromate is dutiable as a color under paragraph 63 rather than as chrome green under paragraph 54 of the act of 1913. (Abstract 37081.)

A pigment is a special kind of coloring matter and a lake is a particular species of pigment. (Farbwerke-Hoechst Co. *v.* United States, 6 Ct. Cust. Appls., 483.)

Chrome green, ocher, umber, and sienna colors of fine grades, put up in tubes for artists' use, were held to come within the provision in paragraph 61 of the act of 1890, "artists' colors of all kinds, in tubes," because commercially known as artists' colors in tubes and not within the provision of the colors by name. (Rich *v.* United States, 61 Fed., 501.)

Artists' colors and paints derived from indigo and alizarin are dutiable under the act of 1916 rather than under the provision for artists' paints or colors, or color lakes, in this paragraph. (G. A. 8110, T. D. 37429.) So is tuscan red. (Abstracts 42413 and 42464.) Artists' colors, consisting of coal-tar or alizarin lakes, put up in tubes, are likewise dutiable under the revenue act of 1916. (Abstract 42465.) Small wooden paint boxes containing water colors, crayons, brushes, and drawing materials, called water-color boxes, and reasonably adapted for other purposes than for the amusement of children, were held dutiable as artists' colors under this paragraph rather than as toys under paragraph 342. (Illfelder *v* United States, 7 Ct. Cust. Appls., 53.) By agreement between the Government and importers this decision is not applied to paints or colors in wooden or paper boxes valued at less than 100 marks per gross or in metal boxes valued at less than 25 marks per gross, or the equivalent in each case in francs. They are classified as toys. (T. D. 37168.)

See also Survey on Ceramic and Glass Fluxes, Enamels, and Colors.

CRAYONS AND FUSAINS.

General Information.

ACT OF 1913.

63. * * * crayons including charcoal crayons or fusains, * * * 15 per centum ad valorem * * *.

DESCRIPTION AND USES.

The term crayon refers to pencils composed of charcoal, clay, or chalk and mineral waxes colored with various pigments. They are used for drawing and writing on various materials and also for artists' purposes. Ordinary white crayons used for blackboard purposes are composed chiefly of chalk (calcium carbonate). Black crayons other than charcoal are composed of clay and lampblack. Fusains is an old and practically obsolete term for charcoal crayons. Crayons used for drawing on lithographic stones are commonly made of wax, lampblack, soap and resins. The ordinary wax crayons are composed chiefly of paraffin wax colored with various colors and dyes.

Pastel is a mixture of chalk and colors worked into a paste with "gum" water.

DOMESTIC PRODUCTION.

The materials necessary for the manufacture of crayons are available from domestic sources. The Census of 1914 reports under artists' materials a production of crayons, valued at $181,000 by 11 establishments, with a capital of $325,000 and employing 127 persons It is doubtful whether this includes ordinary crayons used for schoolroom work.

The American Crayon Co. of Sandusky, Ohio, is the largest single manufacturer of crayons in this country. According to Moody's Manual of Industrials for 1920 this firm's authorized capital stock amounts to $1,000,000 common, and $500,000 preferred, of which all of the common is outstanding and $102,500 of the preferred.

IMPORTS INTO THE UNITED STATES.

With the exception of 1914 and 1915 when imports were valued at $18,000 and $15,000, respectively, the imports of crayons and fusains have been fairly constant at between $10,000 and $12,000. The imports for the 1919 calendar year were 14,109 pounds valued at $12,218.

On the basis of value the imports were 10 per cent of the production of crayons reported by the Census of 1914.

TARIFF HISTORY AND CONSIDERATIONS.

Crayons were dutiable at 20 per cent ad valorem under the act of 1883. The duty under the acts of 1890 and 1894 was 25 per cent ad valorem, and under the act of 1897 it was 30 per cent. The act 1909 added to crayons the provision "including charcoal crayons or fusains" and continued the duty of 30 per cent. The act of 1913 retained the same wording but reduced the duty to 15 per cent ad valorem.

There is no special problem connected with crayons. Fusains is an old and obsolete name for charcoal crayons and might be omitted. Since crayons are a manufactured product ready for consumption and since their manufacture involves no chemical process they might well be provided for in Schedule N, Sundries, rather than in a paragraph with articles to which they bear no relation.

Crayons, including charcoal or fusains—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1910	30 per cent		$8,688	$2,606		30
1911	do		11,372	3,411		30
1912	do		9,362	2,808		30
1913	do		12,925	3,877		30
1914	do		4,295	1,288		30
	15 per cent		14,064	2,109		15
1915	do		15,090	2,263		15
1916	do		11,535	1,730		15
1917	do		12,945	1,941		15
1918	do		10,282	1,542		15
Calendar year:						
1918			11,093	1,664		15
1919		14,109	12,218	1,833	$0.86	15

Crayons and fusains—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	423	Crayons of all kinds	20 per cent ad valorem.
1890	61	* * * crayons * * * not specially provided for in this act	25 per cent ad valorem.
1894	48	* * * crayons * * * and not specially provided for in this act.	Do.
1897	58	* * * crayons * * * not otherwise specially provided for in this act.	30 per cent ad valorem.
1909	56	* * * crayons, including charcoal crayons or fusains * * * not otherwise specially provided for in this section.	Do.
1913	63	* * * crayons, including charcoal crayons or fusains, * * * not specially provided for in this section.	15 per cent ad valorem.

Court and Treasury Decisions.

Toilet crayons, consisting of coloring matter put up in convenient form for toilet use, not being crayons of commerce, were held dutiable as toilet preparations under the act of 1890. (G. A. 3497, T. D. 17180.)

An importation invoiced as "black chalk refills" was held, in the absence of proof that the merchandise was not crayons, to be dutiable under paragraph 56 of the act of 1909. (Abs. 34029, T. D. 33872.)

Under the act of 1897 fusains or charcoal crayons used in drawing or sketching were classified as crayons and not as articles composed of carbon. Charcoal was declared not to be carbon. (G. A. 6021, T. D. 26307.)

An importation invoiced as "Conte crayons," consisting of a small stick of black composition incased in a wooden cylinder, was held dutiable under the act of 1890 as pencils of wood and not as crayons. (G. A. 2722, T. D. 15229.)

Small red cylindrical sticks, a mixture of clay and grease with a lake consisting of oxide of lead with rosin red, designed to be inclosed in wood and used as pencils were held dutiable as pencil leads and not crayons under that act. (G. A. 2457, T. D. 14735.)

Pencils of wood from 4 to 7 inches in length, filled with material of various colors and known in trade and commerce as colored pencils and often as school crayons, were held dutiable as pencils and not as as crayons under the act of 1883. (In re Blumenthal, 49 Fed., 226.)

CERAMIC AND GLASS ENAMELS, FLUXES, GLAZES, AND COLORS.

General Information.

TARIFF ACT OF 1913.

63. * * * smalts, and frostings, and all ceramic and glass fluxes, glazes, enamels, and colors, whether crude, dry, mixed, or ground with water or oil or with solutions other than oil, not specially provided for in this section, 15 per cent ad valorem; * * *.

96. Fusible and glass enamel, not specially provided for in this section, 20 per cent ad valorem.

493. Glass enamel, white, for watch and clock dials. (Free list.)

The provisions quoted above include a group of very similar ceramic products which are used in the manufacture of glass, pottery, and enamel iron wares and for enameling various other articles.

ENAMELS.

Description and uses.—Enamels may be described as glasses containing a metallic oxide as a pigment to render the glass opaque or colored as desired. Although enamels may be applied to pottery, the term "enameling" is usually understood to refer to the application of enamels to metallic bodies, usually steel or cast iron.

Although an enamel is a glass, the fact that it must adhere to steel and resist the abuse common to cooking utensils, makes necessary the addition of other ingredients besides those used in ordinary glass. One of the primary requirements of an enamel is that it adhere firmly to the metal body after fusion. This requires that the enamel must have as nearly as possible the same coefficient of expansion as the body of the ware.

Enamels are used chiefly as a protective coating, which will resist the action of alkalies, acids or other chemicals, and which will withstand punishment by impact and by rapid changes of temperature. They are also used for decorative purposes. The biggest use of enamel is for coating ironware, such as represented by cooking and hospital utensils and bathroom fixtures. It is also used for signs, window letters, buttons, dials for watches and clocks, novelties, and various other articles.

Composition and materials.—Enamels are complex silicates or borosilicates of sodium, potassium, calcium, and aluminum. In addition they contain various metallic oxides to produce opacity or color.

The principal materials entering into the manufacture of the enamel are quartz and flint, which supply the silica; fluorspar, which supplies calcium or lime; feldspar, which is a complex sodium, potassium, aluminum, silicate, and borax or boric acid. Clay is used with enamels to be slushed on. The ingredients of the enamel vary with the result desired and materials other than those enumerated are used in special cases.

Tin oxide is one of the most important and expensive materials entering into enamels. It is used to produce white enamels, which contain from 5 to 10 per cent of tin oxide. Cobalt is used for blue; manganese for violet and brown; nickel for gray; copper or chromium for green; uranium or titanium for yellow; and iron, selenium, or gold for red enamels.

Manufacture and application.—In the manufacture of enamels the various materials are weighed out carefully and stored in separate bins for each kind of enamel. The raw material for the various enamels is fused in furnaces similar to those used in the manufacture of glass, at a temperature which ranges from 1,000° C. to 1,300° C. The temperature in these furnaces is controlled by pyrometers. When the enamel is melted into a liquid condition, it is run out of the furnace into a tank of cold water, which cracks the glass into small pieces. This "quenching" toughens the enamel and facilitates the process of grinding. This product is knwon as "enamel frit," which is then ground in ball mills with about 50 per cent of water and several per cent of white ball clay. For white enamels tin oxide is added at this time. The material as it leaves the ball mills is of the consistency of rich cream.

The steel or iron vessel to be enameled is dipped into the large pans containing the mixture of enamel, water, and clay. When removed,

the wet enamel forms a filament over the entire surface. The excess of enamel is thrown off by a general swinging motion and the vessel is then placed on supports in a muffle furnace and subjected to a temperature sufficient to fuse the enamel into a solid glazed coating, the process requiring from three to five minutes. If the vessel is to have more than one coating, the operation is repeated. The best grade of enamel ware receives three coatings.

Organization and size of the industry.—The larger manufacturers of enameled ware make their own enamels. They usually buy the raw materials and mix these according to their own formulas, which are carefully guarded. The industry is still in a very secretive stage, and everything possible is done to prevent workmen from obtaining any knowledge of the ingredients of the enamels. The number of firms manufacturing enamel frits for sale to manufacturers of enameled ware is comparatively small, and the industry does not represent a large capital investment.

Practically all of the large watch and clock manufacturers make their own enamel for their dials, which is a special grade of white enamel.

The census of manufactures, 1914, reported 77 enameling establishments with a capital of $2,128,000 and with an output valued at $2,166,000. The enameling industry has expanded greatly during the war owing to cessation of imports of foreign enamel ware. The industry has also made marked advances in the art of enameling and the quality of the ware produced. This can largely be accounted for by application of scientific and technical knowledge in the industry, which has replaced rule of thumb practices to a marked extent during the war period.

CERAMIC AND GLASS COLORS, GLAZES AND FLUXES.

Description.—The ceramic colors are a distinct article of commerce and differ essentially from the paint pigments. They are colors which are used in the manufacture of glass, for the coloring of glaze on pottery and other earthenware, and for coloring enamels, previously described. All these colors are of inorganic nature and must be able to withstand the temperature in firing the ware, which limits the colors that can be used. The ceramic colors are chiefly metallic oxides, and the same colors are used for producing transparent colored glass. In general, the oxides used are the same as previously described for coloring enamels.

The colors are applied to the pottery or earthen ware by one of three methods: (1) By applying the coloring materials to the body of the ware, which is afterwards glazed with a transparent glaze, a process known as "under glaze"; (2) by placing the coloring materials on an already glazed article and refiring the ware, which is known as "on glaze;" and (3) by mixing the color with the glaze and applying the two simultaneously. This process is known as the "colored glaze" method.

The glazes used in ceramic manufacture are either silicates of the alkali or alkaline earths, with or without lead. In other words, they are simply a glass. The proportion of lead used affects chiefly the melting point of the glaze; a glaze containing a high percentage of lead will have a low melting point, and vice versa. The ma-

terials used chiefly for glazing are certain natural silicates, such as feldspar, china clay or kaolin mixed with flint or sand, chalk, borax, soda, and lead. As some ingredients of the glaze are soluble in water, the mixture is usually fused into a glaze before being applied on the ware, which converts the materials into complex insoluble silicates. This process is known as "fritting." All or a part of the glaze to be applied may be previously treated by this process. The larger part of the ceramic colors are treated in this manner before being sold to ceramic manufacturers.

Smalts are colored glazes, consisting chiefly of obalt silicates. While they are strictly colored glazes and are frequently used as ceramic colors, they are also valuable pigments, especially for use in artists' colors. (For a complete description of smalts, see T. I. S. unit on cobalt and cobalt oxide, par. 24, Act of 1913.)

Frostings are made from coarsely powdered thin plates of glass and are used for decorative purposes, particularly on signs. They are also used to produce a "matt" finish for glass enamels.

Uses.—These products are used wholly in the ceramic industry in glazing, enameling and decorating, and in the manufacture of ceramic decalcomanias, or mineral transfer designs for pottery use. The designs are printed on paper from lithographic stones and are used exclusively in the pottery trade. Although the value of the decalcomania will vary with the value of the ceramic color, their chief value frequently lies in their artistic quality and beauty of design. Usually colors are mixed with a special melting body—"flux"— and with an oil for a vehicle. This mixture, which resembles a paint, is then applied to the ware with a brush and allowed to dry. The painted ware is then placed in a kiln and heated to a temperature which is sufficient to fuse the color mixture, but not the glass, china, or vitreous body of the ware. The degree of heat applied ranges from 900° to 3,000° F., and the particular shade desired is dependent not only upon the material used for the color but also upon the temperature and length of firing the ware.

Ceramic colors are sometimes ground in oil and put up in tubes similar to artists' colors. These are used for hand decoration of china and pottery. These ceramic colors are not comparable with artists' colors used for oil painting, as they must be fired after application to the ware.

IMPORTS INTO THE UNITED STATES.

Imports of fusible and glass enamel, prior to the war, ranged from $12,000 to $17,700. Imports from 1915 to 1919, inclusive, were sporadic and ranged from $3,731 in 1916 to $12,078 in 1917. During the 1919 calendar year the imports showed a considerable increase to $17,727.

Imports of white enamel for watch and clock dials have been about equal to those of fusible and glass enamels. From 1910 to 1914, inclusive, the imports ranged from $13,000 to $21,700. During the war period imports varied greatly and ranged from about $5,000 in 1916 to $13,600 in 1917. The imports for the 1919 calendar year show an increase to $16,778. Imports of white enamel for watch and clock dials, given by countries prior to 1915, show that approximately

three-fourths of the imports were from France. Switzerland, Germany, and the United Kingdom were the other important sources.

The imports of "glazes, fluxes, enamels, and colors, ceramic and glass," were valued at about $12,000 in 1912 and 1913. Following the reduction in duty from 30 to 15 per cent by the act of 1913 the imports increased to a maximum of $70,782 in 1915, which was between five and six times the value of prewar imports. The imports then gradually declined to $22,839 in 1919. During the 1919 calendar year the imports show a slight increase to 25,841 pounds, valued at $30,137. As the value of imports only is given, the apparent increase may be accounted for in part by an increase in value of these products.

The total imports of the products above amounted to $71,000 in 1914. Imports from 1915 to 1919, inclusive, ranged from $35,095 in 1919 to $89,088 in 1915. During the 1919 calendar year the imports totaled $64,642.

PRICES.[1]

The price of these ceramic materials varies greatly with the metallic oxide used as a color.

Ordinary white enamel for sheet and cast iron is quoted at about $1.50 per pound. Colored enamels are higher in price and run up to $3 per pound. As the large enameling works make their own enamel, the bulk of enamel does not enter trade channels.

Enamel colors vary even more in price than the enamels. Very few of the colors sell for less than $1.50 per pound and run up to as high as $30 per pound for colors which are not made of precious metals.

Liquid colors made of gold, silver, and platinum sell from $60 to $150 per pound, while gold powders sell for as much as $2.50 per gram ($1,000 per pound).

Fluxes for enamels are quoted at about $1.25 per pound.

TARIFF HISTORY.

Smalts and frostings were provided for on the dutiable list of the tariff acts of 1890 to 1913, inclusive. The duty under the acts of 1890 and 1894 was 25 per cent ad valorem; under the acts of 1897 and 1909, 30 per cent ad valorem, and under the act of 1913 the duty was reduced to 15 per cent ad valorem.

A provision for glazes, fluxes, enamels, and colors used in the ceramic and glass industry was inserted in the act of 1909, and these products were dutiable at 30 per cent ad valorem. The act of 1913 reduced the duty to 15 per cent ad valorem.

In the act of 1897 provision was made on the free list for "glass enamel, white, for watch and clock dials." This provision has been retained on the free list of the two subsequent tariff acts.

In the act of 1890 fusible enamel was made dutiable at 45 per cent ad valorem, and in the acts of 1894 to 1909, inclusive, at 25 per cent ad valorem. In the act of 1913 the provision was changed to read: "Fusible and glass enamel, not specially provided for," and the duty reduced to 20 per cent ad valorem.

[1] Based on price list No. 12 of the Roessler & Hasslacher Chemical Co., 100 William Street, New York, Published in 1912. Statement: 1920 prices, 25 per cent higher

In the act of 1913 there are three separate and distinct provisions for enamels. Two of these provide for a duty, while the third—for white glass enamel for watch and clock dials—is free of duty. All of these materials are very similar products both in chemical composition and method of manufacture. There is no apparent distinction between fusible enamel in paragraph 96, and ceramic enamel in paragraph 63. White glass enamel used for watch and clock dials is similar in composition to any other glass or ceramic enamel except that it requires special properties which permit of its being cut, chamfered, and ground during the process of manufacture. Any distinction in enamels by application or use is subject to classification of enamels intended for other purposes under that provision, and there is no apparent reason why there should not be one provision for all kinds of enamels, and this provision should receive one tariff treatment—whether dutiable or free.

As these materials are chiefly ceramic manufactures and the colors described in paragraph 63 are entirely different from paint pigments, it would seem more logical to provide for these products in a separate paragraph to be included in Schedule B.

Glass enamel, white, for watch or clock dials [1]*—Imports by countries (fiscal years).*

Imported from—	1909	1911	1912	1913	1914
Austria	$24	$351	$250	$157	$366
Belgium				18	
France	4,794	13,527	12,362	9,464	8,757
Germany	506	2,022	1,289	2,229	379
Switzerland	957	3,764	2,437	3,031	2,689
England	796	1,305	1,663	956	779
Total	7,077	20,969	18,001	15,855	12,970

[1] Included in "All other articles," free in 1910 and after 1914.

Total imports of glazes, fluxes, enamels, and colors, ceramic and glass, fusible and glass enamel and white enamel for watch and clock dials—Imports for consumption—Revenue

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
1910			$36,766			
1911			53,547			
1912			44,928			
1913			39,961			
1914			70,803			
1915			89,088			
1916			72,799			
1917			69,103			
1918			45,100			
1919			35,095			
Calendar year 1919			64,642			

Glazes, fluxes, enamels, and colors, ceramic and glass—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	30 per cent ad valorem.		$2,618	$785		30
1911	do		16,334	4,900		
1912	do		12,323	3,696		
1913	do		12,109	3,632		
1914 [1]	do		964	289		
1914 [2]	15 per cent ad valorem.		38,527	5,779		15
1915	do		70,782	10,617		
1916	do		64,138	9,620		
1917	do		43,421	6,513		
1918	do		26,583	3,987		
1919	do	19,046	22,839	3,426		
Calendar year 1919	do	25,841	30,137	4,521	$1.17	15

[1] From July 1 to Oct. 3, 1913. [2] From Oct. 4, 1913, to June 30, 1914.

Fusible and glass enamel, n. s. p. f.—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1910	25 per cent		$17,698	$4,424		25
1911	do		15,511	3,877		25
1912	do		14,604	3,651		25
1913	do		11,997	2,999		25
1914 [1]	do		4,461	1,115		25
1914 [2]	20 per cent		13,567	2,713		20
1915	do		10,975	2,195		20
1916	do		3,731	746		20
1917	do		12,078	2,415		20
1918	do		8,052	1,610		20
1919	do		5,671	1,134		20
Calendar year 1919			17,727	3,545		20

[1] July 1 to Oct. 3, 1913, under act of 1909. [2] Oct. 4, 1913, to June 30, 1914, under act of 1913.

White enamel for watch and clock dials—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
1910	Free		$16,450			Free.
1911	do		21,702			Do.
1912	do		18,001			Do.
1913	do		15,855			Do.
1914	do		13,284			Do.
1915	do		7,331			Do.
1916	do		4,930			Do.
1917	do		13,604			Do.
1918	do		10,465			Do.
1919	do		6,585			Do.
Calendar year 1919			16,778			

Colors, glazes, fluxes, and enamels, ceramic and glass—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1890	61	All * * * colors, whether dry or mixed, or ground in water or oil, including * * * smalts, and frostings, not specially provided for in this act.	25 per cent ad valorem.
1894	48	All * * * colors, and pigments, whether dry or mixed, or ground in water or oil, or other solutions, including * * * smalts, and frostings, and not specially provided for in this act.	Do.
1897	58	All * * * colors, pigments, * * * smalts and frostings, whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this act.	30 per cent ad valorem.
1909	56	All * * * colors, pigments, including * * * smalts and frostings, whether crude or dry or mixed, or ground with water or oil with solutions other than oil, not otherwise specially provided for in this section; * * * all glazes, fluxes, enamels, and colors used only in the manufacture of ceramic, enameled, and glass articles.	Do.
1913	63	* * * smalts, frostings, and all ceramic and glass fluxes, glazes, enamels and colors, whether crude, dry, mixed, or ground with water or oil or with solutions other than oil, not specially provided for in this section.	15 per cent ad valorem.

Glass enamel, white, for watch and clock dials—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	564	Glass enamel, white, for watch and clock dials	Free.
1909	576	.....do	Do.
1913	493	.....do	Do.

Fusible and glass enamel—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1890	122	* * * fusible enamel	45 per cent ad valorem.
1894	101	Fusible enamel, * * *	25 per cent ad valorem.
1897	113	Fusible enamel	Do.
1909	110	.....do	Do.
1913	96	Fusible and glass enamel, not specially provided for in this section	20 per cent ad valorem.

COURT AND TREASURY DECISIONS.

Powders composed in different proportions of silica, alumina, alkalies, tin, copper, zinc, magnesia, etc., were held dutiable under paragraph 6 of the act of 1909 as ceramic colors. (Reusche *v.* United States, 3 Ct. Cust. Appls., 387.)

Colors imported in 10-pound tins to be transferred to tubes for sale to artists and to schools without further manipulation were held properly classified under the second provision of paragraph 63 of the act of 1913. (Abstract 3708, T. D. 35020.)

Merchandise invoiced as dunkelpurpur, a ceramic color and also a mixture of which gold constituted the element of chief value, was held dutiable under this paragraph as a ceramic color and not under paragraph 65 as a mixture of which gold constituted the element of chief

value. (Drakenfeld & Co. *v.* United States, 9 Ct. Cust. Appls. 124, T. D. 37979.)

Enamel having the appearance of glass or a crystalline aspect, imported in thin, flattened, pressed, variously colored cakes, which in its use is finely powdered, mixed with water to a paste, applied to the metal article to be enameled, and then fired by intense heat, thereby fixing it to the surface of the metal, is dutiable under this paragraph as fusible enamel, and not under the provision for "all ceramic and glass fluxes, glazes, enamels, and colors, * * * n. s. p. f." in paragraph 63. (G. A. 7873, T. D. 36228.) So-called "enamel for jewelry" or ceramic color which, while shown to be one of the ingredients of an enamel, can also be used by itself as an enamel in enameling jewelry, is likewise dutiable under this paragraph. (Abstract 40875.)

In the act of 1913 there are three provisions for enamels all similar in chemical composition and method of manufacture: Paragraph 63, for "all cermaic and glass fluxes, glazes, enamels, and colors, whether crude, dry, mixed, or ground with water or oil or with solutions other than oil, not specially provided for in this section, 15 per cent ad valorem"; paragraph 96, for "fusible and glass enamel, not specially provided for in this section, 20 per cent ad valorem"; and paragraph 493, which exempts from duty "glass enamel, white, for watch and clock dials."

(See also survey on Paints of all kinds.)

COLOR LAKES.

General Information.

DESCRIPTION AND USES.

Tariff act of 1913.—Paragraph 63. "* * * all color lakes, whether dry or in pulp, not specially provided for in this section, 20 per cent ad valorem."

Tariff act of 1916.—Section 500, Group III. "All * * * color lakes * * * not otherwise specially provided for in this title, when obtained, derived, or manufactured in whole or in part from any of the products provided for in Groups I and II, natural alizarin and indigo, and * * * or color lakes obtained, derived, or manufactured therefrom, 30 per cent ad valorem."

Section 501 levies an additional duty of 5 cents per pound.

Color lakes or lake pigments are composed of a coloring principal absorbed by or precipitated on an inert and insoluble base. The base of the color lakes is almost invariably inorganic and generally, although not invariably, white or transparent. The term color lake was formerly used commercially to designate those pigment colors produced by fixing the coloring principals on a transparent base, such as aluminum hydroxide. This no longer holds true and the term includes all pigments produced by fixing a dye on an inert base. The base materials used include aluminum hydroxide, alumina, blanc fixe, or precipitated barium sulphate, lead sulphate, lithopone, ground barites, gypsum, whiting, china clay, calcium carbonate (precipitate chalk), barium carbonate, and the native clays, ochers, and umbers. In general, any inert and insoluble body that can be powdered readily and whose natural color does not injure the desired

shade of the lake may be used as the base. The features generally sought in the bases or carriers are (1) covering power, (2) easy working, and (3) fastness to outside influences, such as alkalies, the weather, acids, and light.

Color lakes, according to the coloring matter used, may be divided into two groups, depending on whether the coloring matter or dye is of natural or coal-tar origin.

1. Natural coloring matters (*a*) of vegetable origin, (*b*) of animal origin.
2. Coal-tar dyes.

Color lakes, when first introduced, were all derived from natural dyes, but after the introduction of dyes manufactured synthetically from coal tar the group of color lakes manufactured from them soon became of primary importance. The coal-tar color lakes are now by far the most important class.

Color lakes may be subdivided according to the method of fixing the coloring matter on the inert base as follows:

1. Coal-tar dyes precipitated by barium chloride.
2. Coal-tar dyes precipitated by lead salts (lead acetate and nitrate.)
3. Coal-tar dyes precipitated by tannin or tannin-tartar emetic.
4. Coal-tar dyes precipitated by alumina.
5. Coloring matters directly produced by precipitation.
6. Coloring matters absorbed by siliceous material.

This classification can not be regarded as strictly accurate as there are exceptions, and certain conflicts between groups.

The above classifications of color lakes are all technical; the commercial classification is based on the actual color of the lake produced and not on the method of precipitation or class of dye used. Color lakes are placed on the market in the form of a powder, irregular lumps, regular shapes—drops, cones, tablets, cakes—and in pulp (water paste) which is used especially in the manufacture of wall paper.

DOMESTIC PRODUCTION.

Raw materials.—The base materials generally used in the manufacture of color lakes have been enumerated above. The more expensive and transparent color lakes are made on aluminum hydroxide as the base. These colors are used in artists' colors and in lithographic printing. The development of multi-color lithography has been directly dependent on the development of these transparent color lakes. For decorative paints and wall paper printing this transparency is undesirable and opaque bases are used, which are also generally cheaper. The cost of a color lake is generally dependent on the cost of the dye rather than on the cost of the base.

Process of manufacture.—In general the production of color lakes is a comparatively simple industrial operation. It requires no special or complicated machinery, but careful control is necessary to produce the desired shade of color.

The manufacture consists in mixing the base with water, the solution of dye is then added to the mixture in agitation and in the case of lakes produced by absorption of the color, this completes the fixing of the dye on the base. In cases where a precipitant is used

it is now added to the mixture of base and dye with constant agitation until the dye has been completely precipitated on to the base. The color lake is then filtered from the solution and dried if the dry product is desired. Most of the coal-tar dyes used are soluble in water. In some cases where the calcium or magnesium salt of the dye is insoluble the water used must be softened so as to prevent precipitation of the dye on solution in water. In other cases, alcohol, acetic acid, and other chemicals are necessary to dissolve the dyes.

Production and consumption.—The total production of color lakes is not available as the output is combined under the paint and varnish industry with other paint pigments. The domestic output, however, supplies practically the entire domestic consumption as imports are small.

The production of color lakes manufactured from coal-tar dyes as shown by the annual census of dyes taken by the Tariff Commission was 5,092,558 pounds valued at $2,764,064 in 1917, and 9,590,537 pounds valued at $5,020,023 in 1918. Red lakes including lithol and para reds were the most important in 1918; the production was about 2,500,000 pounds, or about one-fourth of the total output. The other colors in order of output were: Yellow, scarlet, green, and blue lakes. The 1919 output was 7,569,921 pounds.

IMPORTS INTO THE UNITED STATES.

The imports of color lakes prior to 1914 were combined with all other paints, pigments, and colors. The maximum imports since then were valued at $153,430 in 1915. Imports then decreased, until in 1918 only $8,301 were entered. This decrease might be accounted for by coal-tar color lakes becoming dutiable after 1916, at another rate of duty, but the imports of coal-tar lakes have been small. Imports have been less than 1 per cent of the domestic production of coal-tar lakes alone, which is the most important group of color lakes.

PRICES.

The price for coal-tar color lakes in 1918 ranged from 27 cents per pound for green lakes to $1.27 for lithol red lakes. The average price for all color lakes was 52 cents per pound in 1918, and 54 cents in 1917. (Based on average prices reported by manufacturers to the Tariff Commission.)

The price of para red toners, concentrated, was about 60 cents per pound prior to 1915, when the price started to increase and during 1916 the price was about $2.50 or about four times the prewar prices. In 1917 the price declined and in 1918–19 was between $1.50 and $1.70 per pound. During 1920 the price increased to $1.90 per pound.

The price of carmine No. 40, bulk, 11-pound tins, was about $2.75 prior to the war. During the last quarter of 1914 the price increased to $3.50, which was the price in force until the second quarter of 1916 when there was a further increase to $5 per pound. The price since then has ranged from $4.20 in the latter part of 1917, to $5.75 in the third quarter of 1920.

TARIFF HISTORY.

Lakes of all kinds were dutiable at 25 per cent ad valorem under the acts of 1883, 1890, and 1894, and at 30 per cent ad valorem under the acts of 1897 and 1909. The act of 1913 reduced the duty to 20 per cent ad valorem on all color lakes. The act of September 8, 1916, provided that all color lakes manufactured in whole or in part from coal-tar products and those derived or manufactured from natural alizarins and indigo should be dutiable at 30 per cent ad valorem plus 5 cents per pound. The other color lakes remained dutiable under the act of 1913 at 20 per cent ad valorem. The lakes derived from coal-tar dyes are the most important group of color lakes.

Paragraph 63 contains many products which differ from each other in use and in composition. The provision for color lakes in paragraph 63 might be made a separate paragraph.

Coal tar color lakes—Production in United States.

[U. S. Tariff Commission.]

Variety.	1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Blue lakes	411,216	$252,277	753,244	$416,131	543,201	$391,210
Scarlet lakes	397,213	177,859	1,258,364	720,640	865,536	361,904
Eosine lakes	156,984	115,693	303,511	312,352	524,030	530,804
Red lakes	763,321	395,851	1,828,942	844,450	2,101,527	986,765
Lithol red lakes	142,250	108,185	632,663	801,765	565,316	570,687
Para red lakes	623,353	312,631	165,039	141,857	484,306	148,152
Violet lakes	113,011	68,701	245,017	233,196	259,378	345,078
Purple lakes	30,291	53,697	(1)	(1)	6,561	4,519
Maroon lakes	221,249	94,340	632,826	237,322	697,699	260,769
Alizarin lakes	(1)	(1)	(1)	(1)	(1)	(1)
Orange lakes	249,349	89,896	694,350	374,456	246,710	92,291
Yellow lakes	200,786	157,313	1,913,123	626,922	610,445	238,324
Green lakes	387,373	119,133	1,042,803	278,168	466,977	214,697
Brom-acid lakes	(1)	(1)	(1)	(1)	(1)	(1)
Black lakes	(1)	(1)	(1)	(1)	(1)	(1)
All other	1,270,577	767,692	.....	.....	.....	.....
Total	5,092,558	2,764,064	9,590,537	5,020,023	7,569,921	4,179,964

[1] Included in "All other."

Color lakes n. s. p. f.—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1914 [1]	20 per cent ad valorem.	.....	$59,603	$11,920	.....	20
1915	.....do.....	.....	153,430	30,686	.....	20
1916	.....do.....	.....	29,839	5,967	.....	20
1917	.....do.....	.....	11,230	2,246	.....	20
1918	.....do.....	.....	8,301	1,660	.....	20

[1] Prior to 1914 included in "All other paints, colors, pigments, etc."

Color lakes—Coal-tar, prices (wholesale)—Average per pound (as reported by manufacturers).

[From Census of Dyes and Coal-tar Chemicals. U. S. Tariff Commission.]

Kinds or grades.	1917	1918	Kinds or grades.	1917	1918
Blue lakes	$0.61	$0.50	Maroon lakes	$0.43	$0.38
Scarlet lakes	.45	.57	Orange lakes	.36	.54
Eosine lakes	.74	1.03	Yellow lakes	.78	.33
Red lakes	.52	.46	Green lakes	.31	.27
Lithol red lakes	.76	1.27	All other	.60	.....
Para red lakes	.50	.86			
Violet lakes	.61	.95	Total (average)	.54	.52
Purple lakes	1.77	.....			

Wholesale prices of Color lakes (per pound).

[From Oil, Paint, and Drug Reporter.]

	Alizarine conc.[1]	Carmine, No. 40, bulk, 11-pound tins.	Carmine amaranth.[1]	Para red tones.		Purple lake.[1]	Rose lake.[1]	Toluidine tones.[1]
				Conc., 100-pound lots.	Commercial.			
January, 1912	.....	$2.75–3.00	.....	$0.60–0.70	$0.07–0.45	.....	.....	.....
April, 1912	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
July, 1912	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
October, 1912	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
January, 1913	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
April, 1913	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
July, 1913	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
October, 1913	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
January, 1914	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
April, 1914	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
July, 1914	.....	2.75–3.00	.....	.60–.70	.07–.45	.....	.....	.....
October, 1914	.....	3.50–3.75	.....	.60–.70	.07–.45	.....	.....	.....
January, 1915	.....	3.50–3.75	.....	.80–1.00	.07–.45	.....	.....	.....
April, 1915	.....	3.50–3.75	.....	.80–1.00	.07–.45	.....	.....	.....
July, 1915	.....	3.50–3.75	.....	1.15–1.65	.16–.70	.....	.....	.....
October, 1915	.....	3.50–3.75	.....	(2)	.16–.70	.....	.....	.....
January, 1916	.....	3.50–3.75	.....	(2)	.16–.70	.....	.....	.....
April, 1916	.....	5.00–6.50	.....	2.50–3.00	.55–.75	.....	.....	.....
July, 1916	.....	5.00–6.50	.....	2.75–3.25	.50–.75	.....	.....	.....
October, 1916	.....	4.75–5.50	.....	2.50–3.00	.40–.60	.....	.....	.....
January, 1917	.....	4.75–5.50	.....	2.25–2.50	.40–.60	.....	.....	.....
April, 1917	.....	5.00–7.00	.....	2.25–2.50	.40–.60	.....	.....	.....
July, 1917	.....	4.50–6.00	.....	1.75–2.00	.40–.60	.....	.....	.....
October, 1917	.....	4.20–4.50	.....	1.75–2.00	.40–.60	.....	.....	.....
January, 1918	$2.75	4.60	$5.50–6.00	1.50–1.80	.35–.50	$1.00–2.50	$0.25–1.25	$5.75–6.50
April, 1918	(2)	4.60	5.50–6.00	1.50–1.80	.35–.50	1.00–2.50	.25–1.25	4.50–6.50
July, 1918	(2)	5.50	5.50–6.00	1.50–1.90	.20–.50	1.00–2.50	.25–.40	4.50–5.50
October, 1918	(2)	5.50	5.50–6.00	1.70–1.90	.20–.50	1.00–2.50	.25–.40	4.50–5.50
January, 1919	(2)	5.50–6.00	5.50–6.00	1.70–1.90	.20–.50	1.00–2.50	.25–.40	5.50–6.50
April, 1919	(2)	5.50–6.00	5.50–6.00	1.60–1.65	.20–.50	1.00–2.50	.25–.40	4.00–4.50
July, 1919	2.50–3.00	4.60–5.00	4.60–5.00	1.60–1.65	.20–.50	1.00–2.50	.25–.40	4.00–4.50
October, 1919	2.50–3.00	5.00–5.10	4.60–5.00	1.60–1.65	.20–.50	1.00–2.50	.25–.40	3.25–3.75
January, 1920	3.75–4.00	5.20–5.50	4.60–5.00	1.65–1.75	.20–.50	1.00–2.50	.25–.40	4.00–4.10
April, 1920	3.75–4.00	5.20–5.50	4.60–5.00	1.90	.20–.50	1.00–2.50	.25–.40	3.75
July, 1920	3.75–4.00	5.75	4.60–5.00	1.90–2.25	.20–.30	1.00–2.50	.25–.40	4.25

[1] Not quoted prior to 1918.

[2] Nominal.

Color lakes (par. 63, act of 1913)—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	87	Colors and paints, including lakes, whether dry or mixed, or ground with water or oil, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	61	All other paints and colors, whether dry or mixed, or ground in water or oil, including lakes * * * not specially provided for in this act.	Do.
1894	48	All other paints, colors, and pigments, whether dry or mixed, or ground in water or oil, or other solutions, including * * * lakes * * * and not specially provided for in this act.	Do.
1897	58	All * * * lakes * * * whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this act.	30 per cent ad valorem.
1909	56	All * * * lakes * * * whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this section.	Do.
1913	63	* * * all color lakes, whether dry or in pulp, not specially provided for in this section.	20 per cent ad valorem.
1916	.....	Sec. 500. Group III. All * * * color lakes * * * not otherwise specially provided for in this title, when obtained, derived, or manufactured in whole or in part from any of the products provided for in Groups I and II, natural alizarin and indigo, and * * * color lakes obtained, derived, or manufactured therefrom.	30 per cent ad valorem.
		Sec. 501. Levies an additional duty of.....	5 cents per pound.

COURT AND TREASURY DECISIONS.

Lakes containing lead were held more specifically provided for as "colors * * * containing lead" within paragraph 54 of the act of 1897 rather than as "lakes" within paragraph 58 of that act. (United States *v.* Siegle, 1 Ct. Cust. Appls., 32, affirming 175 Fed., 885.)

A *pigment* is a special kind of coloring matter and a lake is a particular species of pigment. "Coal-tar colors" in paragraph 20, act of 1913, was declared a narrower term than "pigments or lakes" in paragraph 63. (Farbwerke-Hoechst Co. *v.* United States, 6 Ct. Cust. Appls., 483, of 1916.)

Bronze lakes and scarlet lakes classified by the collector under paragraph 58 of the act of 1897 as lakes were held to be dutiable under paragraph 54 of that act as colors containing lead. The words "not specially provided for," in paragraph 58, were considered in determining whether "lakes" was a more specific provision than "colors containing * * * lead."

Tuscan red No. 4076DX, claimed to be oxide of iron within paragraph 55 or pigment within paragraph 61 of the 1913 act, was returned by the chemist as containing about 10 per cent of coal-tar coloring matter, some inert dilutent, and the remainder iron oxide with a little moisture inherent in colors. The definition in the Oxford dictionary of the word "lake" was followed, and the merchandise held dutiable accordingly under paragraph 63 of the act of 1913. (Abstract 40363.)

Tuscan red, a coal-tar color lake composed of oxide of iron and containing about 4 per cent of aniline color, was held dutiable under Group III of section 500 of the revenue act of September 8, 1916, at 30 per cent ad valorem, plus the special duty of 5 cents per pound imposed in section 501. (Abstracts 42413, 42464, and 43708.) An appeal is pending in the Court of Customs Appeals from Abstract 43708 upon the question whether the special duty of 5 cents per pound accrued. (T. D. 38444.)

CADMIUM SULPHIDE AND OTHER CADMIUM PIGMENTS.

[Par. 63, Act of 1913, n. s. p. f.]

SUMMARY.

DESCRIPTION AND USES.

Cadmium sulphide (CdS) or cadmium yellow (or orange) is a brilliant yellow or bright orange compound, containing approximately 78 per cent of cadmium. The color shade depends upon the manner of manufacture.

Up to 10 or 15 years ago cadmium sulphide was a very rare and costly article used exclusively as an artist's color. The growth in cadmium production has attracted added interest to the manufacture of this high grade pigment for more general uses. One of the earliest industrial applications of cadmium sulphide was for the painting of railroad coaches. This pigment is the only yellow that is not blackened by exposure under these trying conditions.

In addition to its use as a paint pigment, there is a limited consumption of cadmium sulphide as a coloring agent in toilet soaps, ceramic and glass glazes, and in pyrotechny.

PRODUCTION.

The first production of cadmium sulphide on a commercial scale in the United States was made in 1911. Except for a temporary setback in 1915, the production increased steadily and comparatively rapidly to over 50,000 pounds, valued at $70,939, in 1917. Previous to the domestic production the cadmium pigment trade was supplied from Germany, where it had been manufactured for many years. Data as to the foreign production, coming practically exclusively from Germany, are not available; but it is certain that the United States is now the largest producer of cadmium sulphide, as well as of cadmium metal, in the world.

Cadmium sulphide can be made from many of the cadmiferous residues and products of smelting works and from the flue dust at brass foundries. Possible important sources of cadmium compounds are the precipitates obtained in the purification of zinc solutions for the manufacture of lithopone and in the electrolytic recovery of zinc. In addition to cadmium, hydrogen sulphide gas or an alkaline (sodium or ammonium) sulphide go into the manufacture. Very little equipment is required for cadmium pigment manufacture in addition to that found in any paint or pigment factory.

Cadmium yellow is of necessity a minor product, if not a by-product, of other operations; hence, little idea can be gained as to the actual capital invested in its manufacture. Several of the eastern pigment works make this product and it is also made by the large smelting companies, chiefly in eastern plants, where it generally is made from surplus cadmium metal or salts that can not be absorbed by the market in metallic form.

EXPORTS.

Cadmium sulphide has been exported in recent years, but the amount has been negligible. No records of these exports can be secured at present.

IMPORTS.

Cadmium sulphide was imported from time to time from Germany before the war. The importation was never sufficient to warrant separate classification by the Department of Commerce and it was grouped with other paints and pigments. So far as can be ascertained, there is no importation of this pigment at present (1916–1918). The domestic output is ample to supply the demand. It is not believed foreign material could be placed on the American market at an attractive price.

PRICES.

Cadmium sulphide is not regularly quoted in the trade journals. The market is largely contractual, even for small lots. The prices given on page 11 of this catalogue are obtained by dividing the total values reported by producers by their output.

The price per pound of cadmium sulphide is sometimes a little more and sometimes a little less than that of cadmium metal. While its cadmium content is only 78 per cent, the increased cost of its manuacture would seem to make up in value the difference in content. Price fluctuations are less marked in the sulphide market than in the wider market in which the metal is sold, but the yearly averages show the same general trend—a decided increase during the war period. The price of cadmium sulphide in 1917 was $1.41 a pound, as compared with the price of $0.70 a pound which prevailed in 1914. The rise, amounting to 100 per cent, has been notably steady.

TARIFF HISTORY.

Cadmium sulphide has never had special mention in the tariff. Its status as a pigment rather than a salt was defined by a court decision. Pigments and colors of this class were dutiable at either 25 or 30 per cent in the tariff acts prior to that of 1913. In paragraph 63 of the 1913 act the duties on these commodities were reduced to 15 per cent on the cruder forms of pigment and 20 per cent ad valorem on artists' colors. Any cadmium pigment that is likely to be imported would fall under the higher rate.

General Information.

DESCRIPTION.

Cadmium sulphide or cadmium yellow is a brilliant pigment that mixes well with other pigments, excepting lead and copper compounds, and with oil or water. The color varies from light lemon yellow to orange, and, under certain conditions, a pure, brilliant vermilion or the color of red lead can be prepared. The darker shades have a much higher specific gravity than the lighter shades, are difficult to prepare, and on account of their extremely high density have a less covering power than the same amount of cadmium in the lighter shades.

Other cadmium pigments containing cadmium sulphide or oxide compounded with other substances have been prepared. At least

oneof these products appears to be a valuable pigment with a yellow or orange color scarcely inferior to that of pure cadmium yellow, although the cadmium content is only about one-third that of the original pigment.

Cadmium pigments are extremely permanent and can be heated to a high temperature without injury. They do not change their color or properties on exposure to air or the action of hydrogen sulphide (coal gas, etc.), when properly prepared. It is the only yellow pigment that is not blackened on exposure.

USES.

The chief use of cadmium yellow and other pigments is, of course, in paints. It is also used in ceramics as a glaze color and as a coloring agent in toilet soaps and in calico printing. In pyrotechny it is frequently employed for the production of blue fire. Its use as a paint material was formerly confined to artists' pigments but, more recently, it has been used for painting railroad coaches and other more general industrial purposes.

SUBSTITUTES.

Cadmium yellow is a comparatively expensive pigment. The next most satisfactory yellows are the chromes (chromates of lead, zinc, or barium), which are much cheaper. Those pigments are frequently used as a filler or first coat under cadmium yellow. Yellow ocher, orpiment, litharge, gamboge, and Indian yellow are substitutes for the expensive cadmium light-colored pigments, while orange mineral (Pb_3O_4-lead tetroxide), chrome orange, and antimony orange are substitutes for the darker shades of cadmium colors. None of these substitutes is generally satisfactory as a paint base for any type of work. Practically all of them are acted upon by even ordinary atmospheric agencies, and some of them are highly poisonous. If cadmium pigments were produced at somewhat lower prices, it is probable that it would become the most important yellow and one of the most important orange pigments for paint use.

PRODUCTION.

The United States is doubtless the largest producer of cadmium sulphide at the present time, having superseded Germany which, before the outbreak of the European War, was the largest producing country. England is the only other country where cadmium pigments are made in any quantity and the English production is negligible.

The domestic production began in 1911 with an output of 2,932 pounds, valued at $1,674. The production increased very rapidly to 22,700 pounds in 1914, but fell back in the following year to less than one-half that amount. The 1916 production was nearly as great as that of 1914, and in 1917 more than doubled in amount and more than trebled in value as compared with the 1914 figures.

Data as to the German production are not available.

PROCESS OF MANUFACTURE.

The essential feature of manufacturing cadmium sulphide is the precipitation of the cadmium as sulphide from a solution of a cadmium salt. The solution may contain either the sulphate or the chloride, but not the nitrate. These may be obtained either in the leaching treatment of cadmiferous products by dissolving crystallized salts obtained by the evaporation of cadmium electrolyte or by dissolving the metal in acid.

The precipitation can be effected by treatment with hydrogen sulphide (gas) or alkaline sulphide (solution). The latter method involves less difficulty, but the product is likely to contain free sulphur which causes changes in color when mixed for use. A highly satisfactory product can be easily obtained by gas treatment using a simple but special apparatus, although if hydrogen sulphide gas is simply blown into the liquid complete precipitation is impossible and the product obtained by treatment in an ordinary precipitating tower is not good. It is also obtained as a by-product of lithopone manufacture.

IMPORTS.

The only data available as regards imports of cadmium sulphide are those gathered from a compilation made by Dr. E. J. Pickrell, of the Department of Commerce, for the fiscal year 1914. These show the following importations, all from Germany:

	Quantity.	Value.
	Pounds.	
Cadmium yellow	1,958	$1,912
	935	1,732
Cadmium deep orange	49	187
Cadmium artist color [1]		370
		321
Total		4,522

[1] About 30 per cent of this is from England.

COMPETITIVE CONDITIONS.

The manufacture of cadmium sulphide is a comparatively new industry in the United States, but its status depends largely upon the growth of consumption—both domestic and foreign. It is quite independent of foreign competition, since it forms an important outlet for cadmium. The United States has a very large supply of raw material that could be profitably treated for cadmium or cadmium pigments, if market demands warranted this production. The amount of such material available in this country is greater than that in any other country in the world, not excepting Germany.

Cadmium sulphide is likely to become more and more important. As soon as its price is reduced by large scale production, it is probable that it will succeed other yellow pigments except for the cheapest kinds of paints.

Other cadmium pigments have not yet progressed much beyond the laboratory stage, but their excellent quality, cheapness, and ease of manufacture indicate an immediate adoption and extended use.

Cadmium sulphide—Production in United States.

[From Mineral Resources, U. S. Geological Survey.]

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1900	[1]		1913	17,302	$12,136
1904	[1]		1914	22,723	20,241
1909	[1]		1915	10,624	12,057
1910	[1]		1916	22,176	27,942
1911	2,392	$1,674	1917	50,169	70,939
1912	8,998	6,400	1918	51,702	70,315

[1] No production.

Cadmium sulphide—Average sales prices in dollars per pound.

[From Mineral Resources, U. S. Geological Survey.]

1911	$0.70	1915	$1.13
1912	.71	1916	1.26
1913	.70	1917	1.41
1914	.88	1918	1.36

Cadmium sulphide—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	87	Colors and paints, including lakes, whether dry or mixed, or ground with water or oil, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	61	All other paints and colors, whether dry or mixed, or ground in water or oil, including lakes, crayons, smalts, and frostings, not specially provided for in this act, and artist's colors of all kinds, in tubes or otherwise.	Do.
		All paints and colors, mixed or ground with water or solutions other than oil, and commercially known as artists' water-color paints.	30 per cent ad valorem.
1894	48	All other paints, colors, and pigments, whether dry or mixed, or ground in water or oil, or other solutions, including all colors in tubes, lakes, crayons, smalts, and frostings, not specially provided for in this act.	25 per cent ad valorem.
1897	58	All paints, colors, pigments, lakes, crayons, smalts, and frostings, whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this act.	30 per cent ad valorem.
		All paints, colors and pigments, commonly known as artists' paints or colors, whether in tubes, pans, cakes, or other forms.	Do.
1909	56	All paints, colors, pigments, stains, lakes, crayons, including charcoal crayons or fusains, smalts, and frostings, whether crude or dry or mixed, or ground with water or oil or with solutions other than oil, not otherwise specially provided for in this section.	Do.
		All glazes, fluxes, enamels, and colors used only in the manufacture of ceramic, enameled, and glass articles.	Do.
		All paints, colors, and pigments, commonly known as artists' paints or colors, whether in tubes, pans, cakes, or other forms.	Do.
1913	63	Enamel paints, and all paints, colors, pigments, stains, crayons, including charcoal crayons or fusains, smalts, and frostings, and all ceramic and glass fluxes, glazes, enamels, and colors, whether crude, dry, mixed, or ground with water or oil or with solutions other than oil, not specially provided for in this section.	15 per cent ad valorem.
		All paints, colors, and pigments, commonly known as artists' paints, colors, whether in tubes, pans, cakes, or other forms.	20 per cent ad valorem.
		All color lakes, whether dry or in pulp, not specially provided for in this section.	Do.

Court and Treasury Decisions.

Cadmium yellow was held dutiable as a color under paragraph 61 of the act of 1890 and not exempt from duty as cadmium under paragraph 525. (G. A. 2049, T. D. 13944.)

Cadmium sulphide, sometimes called "cadmium yellow," was held dutiable as a pigment or color under paragraph 58 of the act of 1897, and not as a chemical compound or salt under paragraph 3. The protest claim that it was exempt from duty as cadmium under paragraph 513 was abandoned at the trial. (Drakenfeld *v.* United States, 2 Ct. Cust. Appls., 512.)

VANDYKE BROWN, CASSEL EARTH.

[Par. 63, act of 1913, n. s. p. f.]

General Information.

DESCRIPTION.

Vandyke brown, Cassel earth, and Cassel brown are names applied indiscriminately to a pigment composed of clay, iron oxide, decomposed wood, and some bituminous products. These pigments are obtained from certain bog-earth or peat deposits and are essentially ochers containing bituminous matter.

Cassel brown is not important as an oil color, as the paints dry slowly and have no great covering power, but it has good body, is fairly permanent, and mixes well with other colors. The largest consumption is for wall and fancy paper making. It is also used as a water color and as a base for manufacturing wood stains.[1] It is believed to have been first used by the artist Vandyke, who employed it as a glazing color instead of bitumen. Toch[2] recommends it because of its translucent quality, provided the effect of age is to be simulated.

SUBSTITUTES.

Vandyke browns are made artificially from charred organic substances, such as bark, cork cuttings, and bone dust. Mixtures of lampblack, yellow ocher, and iron oxide are also sold as Vandyke brown.[3] Many painters use a permanent glaze composed of ocher and black, tinted with umber.[4]

PRODUCTION.

Cassel brown is found native mostly as a fine earthy mass, and the preparation is therefore simple. The wet mass from the pits is dried and ground in a disintegrator. Levigation can be dispensed with. The chief source of supply is Germany. None is found in the United States.[5]

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[1] Zerr-Rübencamp-Mayer. Treatise on color manufacture. Griffin. 1908.
[2] Maximilian Toch. Materials for permanent painting.
[3] Thorp. Outlines of industrial chemistry.
[4] Toch. Chemistry and technology of paints.
[5] Letter from Devoe & Reynolds (paint and pigment manufacturers) to United States Shipping Board (Apr. 14, 1919). It should be noted, however, that the Oil, Paint, and Drug Reporter quotes prices (see p. 11) for "Domestic Vandyke brown."

IMPORTS.

Practically the whole supply of Vandyke brown used in the United States is imported. The maximum importation for any one year was in 1912 and was valued at $2,635. Under the 30 per cent duty then in force the total revenue was only $790.50.

Only the declaration values of the imports for consumption are reported in Commerce and Navigation. A survey made by Dr. Pickrell for the Department of Commerce shows that in the fiscal year 1914 the entire importation came from Germany, with the exception of $7 worth from England and $9 worth from France. One importation is listed as "Cassel brown," amounting to 252,514 pounds, with a value of $2,306; another, listed as "Vandyke brown," amounted to 25,910 pounds, with a value of $694.[1] These data suggest a distinction in quality between the two importations since the values per unit of quantity are 0.91 cents and 2.68 cents per pound, respectively. It is quite possible that the former was imported dry and the latter in oil.

Since the outbreak of the European war the average annual imports have been much higher than during any previous period. Their origin has not been investigated.

PRICES.

The prices of Vandyke brown dry, and in oil, were constant from 1914 through 1916, when they rose 7 cents and 14 cents, respectively, this being attributed to the fact that the entire supply which came from Germany prior to the war was now cut off. After the armistice the price of the dry commodity sought the prewar level of 2½ cents and has not increased but 1 cent on the pound for the past two years. The color in oil was not quoted, being entirely off the market after January, 1919.

TARIFF HISTORY.

Vandyke brown has always come under the blanket clause as a color or pigment not otherwise specially provided for. Its tariff history will therefore be found in another catalogue, dealing with the minor pigments.

Brown, Vandyke, Cassel earth or Cassel brown—Imports for consumption—Revenue.

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1911	30 per cent		$491	$147.30		30.0
1912	do		3,192	957.60		30.0
1913	do		2,187	405.60		18.5
1914	15 per cent		1,302	195.30		15.0
1915	do		1,208	181.20		15.0
1916	do		790	118.50		15.0
1917	do		2,759	413.85		15.0
1918	do	33,600	2,573	385.95	$0.077	15.0
1919	do	70,002	2,416	362.40	.035	15.0
1920	do					15.0

[1] The sum of the values as reported by Dr. Pickrell (Miscellaneous Series, No. 82) is $3,016, whereas the total imports for consumption during the same period as reported in Commerce and Navigation is only $2,663.

Vandyke brown, domestic, in ton lots, in barrels; cents per pound.

[From Oil, Paint, and Drug Reporter.]

	Dry.	In oil.[1]	Vandyke brown.		Dry.	In oil.[1]	Vandyke brown.
August, 1914	2½–3	11–14	.....	July, 1919	2½–3½	[2]	.....
January, 1915	2½–3	11–14	.....	October, 1919	2½–3½	.....	.....
January, 1916	3–4	11–14	.....	January, 1920	2½–3½	.....	.....
January, 1917	10	25–30	.....	April, 1920	2½–3½	.....	.....
January, 1918	4–7	25–30	.....	July, 1920	3½–4½	.....	8–10
January, 1919	3½–4	25–35	.....	October, 1920	3½–5	.....	8–10
April, 1919	3½–4	[2]	.....				

[1] Described as "Genuine brown." [2] Not quoted.

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 48, 49, and 50 OF THE TARIFF ACT OF 1913

PERFUMERY, COSMETICS, AND TOILET PREPARATIONS

Paragraph 48:
- Cosmetics
- Perfumery
- Toilet preparations
- Floral or flower waters

Paragraph 242:
- Bay rum

Paragraph 49:
- Ambergris
- Enfleurage greases
- Floral essences
- Flavoring extracts
- Musk
- Civet
- Odoriferous substances, preparations, and mixtures

Paragraph 50:
- Healing and court plasters

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Gift
U.S. Tariff Comm.
6-4-28

PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and Index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Sidney D. Kirkpatrick, of the chemical division of the commission's staff, and of others.

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PERFUMERY, COSMETICS, AND TOILET PREPARATIONS.

(Paragraph 48, Act of 1913.)

SUMMARY.

The articles of perfumery discussed in this chapter are the manufactured products which are ready for use without further treatment. They may be divided into three classes, viz, the so-called "true" perfumes, hygienic toilet preparations, and cosmetics. The true perfumes may be liquid, as in the case of the handkerchief perfumes and toilet waters, or they may be dry powders, such as sachets and fumigating powders. Hygienic perfumery deals with substances having a favorable effect on the health, comprising chiefly the preparations for the care of the skin, hair, teeth, and mouth. Cosmetic perfumery somewhat overlaps the hygienic, but its use is not generally considered beneficial to the health. The principal cosmetics are face powders, rouges, and grease paints for the skin, and dyes, depilatories, and waxes for the hair, and powders and polishes for the nails.

Practically all articles of perfumery are prepared by the blending and compounding of many different constituents. These constituents, commonly known as perfume materials, comprise a wide variety of substances from the animal, vegetable, and mineral kingdoms. The essential oils and various flower products are by far the most important. The animal perfumes, musk, civet, ambergris, and castor, are used in small quantities in many preparations. The aromatic chemicals form the basis of synthetic or artificial perfumes and serve an important purpose in the perfume industry.

The manufacture of perfumes and cosmetics is an important industry in the United States, notwithstanding the fact that the principal perfume materials—especially the essential oils and flower concentrates—are imported from abroad. In 1914, the last year for which production statistics are available, the domestic industry employed over 5,000 persons and had an output valued at about $20,000,000. Since 1914 the industry has expanded to a considerable extent in order to meet an increased demand in foreign and domestic markets. It has been estimated (see p. 18, infra) that the value of the total domestic consumption of perfumes and cosmetics during 1919 was between $80,000,000 and $100,000,000. Domestic exports in 1919 were over ten times the value of exports in 1909 and amounted to but slightly less than $7,500,000. This striking increase in our foreign trade was caused largely by the war, which resulted in the partial or complete elimination of French and German perfumery in many of the world's markets. Particularly is this true in Argentina, Brazil, and other Latin American countries.

Imports of perfumery into the United States have also increased from a value of $1,250,000 in 1910 to $5,000,000 in 1919. About two-fifths of the 1919 imports were of nonalcoholic perfumery; two-fifths of alcoholic perfumes and toilet waters, and the balance was

made up of cosmetics, flower waters, bay rum, etc. France is by far the most important source of supply and furnishes between 80 and 90 per cent of our imports. England and Switzerland supply most of the balance. Grasse, in southern France, is the center of the flower-growing industry of the world and has been an important factor in bringing French perfumery to its present position of supremacy. The Parisian perfumers have gained a reputation of superiority, not only because of the high quality of their products but also because of the artistic taste and ingenuity shown in their presentation. London is also an important perfume center, especially for fine toilet soaps. In Germany and Switzerland the manufacture of the synthetic or artificial products has made most progress.

Perfumery and toilet preparations not containing alcohol were dutiable at 50 per cent ad valorem under the acts of 1883 and 1890 at 40 per cent under the act of 1894, again at 50 per cent under the act of 1897, and since 1909 at 60 per cent ad valorem. Alcoholic perfumery during this period has borne a specific duty in addition to an ad valorem rate. From 1883 to 1897 the compound duty was $2 per gallon and 50 per cent ad valorem. In the act of 1897 this was changed to 60 cents per pound and 45 per cent ad valorem, and the act of 1909 increased the ad valorem rate to 50 per cent. In 1913 the duty was changed to 40 cents per pound and 60 per cent ad valorem. The revenue act of 1917, which increased the internal-revenue tax on alcohol, provided an additional tax of $1.10 per gallon on imported alcoholic perfumes.

The specific duty on alcoholic perfumery in addition to the ad valorem rate has been presumably for the purpose of counterbalancing the internal-revenue taxes on alcohol paid by the domestic manufacturers of these articles. Since the alcoholic content of perfumes varies widely, it is obvious that the specific rate must rest unevenly on different classes of goods. However, a single rate based on the exact alcoholic content or different specific rates on articles whose alcoholic contents fall within certain specified limits present administrative difficulties and would probably involve litigation.

Perfumery and toilet preparations have been important sources of revenue under previous tariff acts. During the period 1909–1919 the annual revenue yielded by alcoholic and nonalcoholic perfumery averaged about $1,250,000.

Perfumery, cosmetics, and toilet preparations—Summary table.

Fiscal year.[1]	Domestic production, value.	General imports, value.	Domestic exports, value.	Ratio to production.	
				Imports.	Exports.
				Per cent.	*Per cent.*
1909	$14,212,000	$1,425,613	$683,253	10	4.8
1910	.....	1,214,792	824,460	.....	.....
1911	.....	1,534,537	1,009,359	.....	.....
1912	.....	1,645,992	1,147,630	.....	.....
1913	.....	1,873,585	1,441,982	.....	.....
1914	19,160,407	2,309,027	1,620,872	12.1	8.5
1915	.....	2,473,144	1,715,059	.....	.....
1916	.....	3,105,906	2,903,063	.....	.....
1917	.....	3,806,699	3,618,620	.....	.....
1918	.....	3,179,749	3,902,670	.....	.....
1919	.....	4,972,541	7,324,422	.....	.....

[1] Production statistics are for calendar years. Imports and exports are for fiscal years from 1909–1917 and for calendar years for 1918–19.

Perfumery, cosmetics, and toilet preparations—Summary table—Continued.

Fiscal year.	Value (imports for consumption).[1]	Amount of duty.	Equivalent ad valorem rate.
			Per cent.
1910	$1,176,329	$765,415	65.07
1911	1,508,218	981,286	65.07
1912	1,611,027	1,055,863	65.54
1913	1,844,142	1,195,923	64.85
1914	1,855,515	1,228,070	66.19
1915	1,678,837	1,113,315	66.31
1916	2,098,456	1,371,474	65.36
1917	2,772,539	1,806,786	65.17
1918	2,501,983	1,607,460	64.25
1919	2,758,087	1,749,980	63.45

[1] The sum of the imports of alcoholic and nonalcoholic perfumery (by fiscal years).

PROVISIONS IN TARIFF ACT OF 1913.

"48. Perfumery, including cologne and other toilet waters, articles of perfumery, whether in sachets or otherwise, and all preparations used as applications to the hair, mouth, teeth, or skin, such as cosmetics, dentifrices, including tooth soaps, pastes, including theatrical grease paints, and pastes, pomades, powders, and other toilet preparations, all the foregoing, if containing alcohol, 40 cents per pound and 60 per centum ad valorem; if not containing alcohol, 60 per centum ad valorem; floral or flower waters containing no alcohol, not specially provided for in this section, 20 per centum ad valorem."

"242. Bay rum or bay water, whether distilled or compounded, of first proof, and in proportion for any greater strength than first proof, $1.75 per gallon."

General Information.

DESCRIPTION AND USES.

The term "perfumery" is generally used to include anything which gives a pleasant odor, and, as used in the tariff law, comprises not only the liquid substances manufactured for the pleasant odors they emit, but also the various cosmetics and toilet preparations.

For the purposes of this chapter the discussion is limited to the finished products, i. e., the articles which, without further treatment, are ready to be applied. The articles of perfumery discussed in the following pages may be divided into three classes,[1] the boundary lines of which, however, can not be clearly defined. These classes are:

1. The so-called "*true perfumes*," which include (*a*) the liquid perfumes, such as the alcoholic extracts, cologne, and toilet waters, handkerchief perfumes and floral waters, and (*b*) the dry perfumes, such as sachet, and fumigating powders, and smelling salts.

2. *Hygienic toilet preparations*, which include the articles purporting to have a favorable effect on the health. Such hygienic preparations comprise most of those used as applications to the hair, mouth, teeth, and skin. The principal preparations for the care of the hair are oils, pomades, tonics, and washes; those for the care of the mouth

[1] Classification adapted from that of Askinson's "Perfumery and Cosmetics" New York, 1915.

and teeth are the dentifrices, such as tooth powders, soaps, and pastes, and mouth washes; those for the care of the skin are lotions, such as bay rum, creams, emulsions, and toilet powders. (Toilet soaps, which are perhaps the most important of this class, are not discussed in this report.)[1]

3. *Cosmetic perfumery* includes the preparations intended to beautify or improve the condition of the skin or the hair. In general, these preparations are not beneficial to the health of the user, and their continued application often proves deleterious. Cosmetics for the skin, which in certain cases might logically fall into either of the preceding classes, consist principally of face powders, rouges, and theatrical grease paints, and pastes. The hair cosmetics are dyes, depilatories, beard and hair waxes, bandolines, and brilliantines. Other articles included in this class are nail powders and polishes, and the pencils or crayons used for coloring the lips and eyebrows.

Perfumery is used for æsthetic, antiseptic, and hygienic purposes. Its æsthetic use is obvious. Its antiseptic value was recognized by the ancients, and perfumery is still used for this purpose, even though cheaper and more efficient antiseptics are now available. Toilet soaps, dentifrices, and similar preparations are often regarded as hygienic necessities.

PRODUCTION AND TRADE.

Importance.—The manufacture of perfumery and cosmetics in the United States represents a large and important industry, which even before the war had an output valued at approximately $20,000,000. The large increase in the price of perfume materials, and the growth of the industry in order to supply an increased demand in both foreign and domestic markets, apparently indicates that the production in 1920 will be at least twice, if not three times, the 1914 output.

Materials used.—The manufacture of perfumes and cosmetics probably consumes a wider variety of materials than any other industry, with the possible exception of the preparation of drugs and medicines. Most of these materials are of vegetable origin, although a few animal products are important, and a large number of mineral, and synthetic chemical substances are largely used. The products of animal origin are only four in number: *Ambergris*, derived from the whale; *musk*, obtained from the musk-deer; *civet*, a secretion of the civet cat; and *castor*, a similar secretion of the beaver. (These articles are discussed in detail in the Tariff Information Surveys for pars. 49 and 442 of the act of 1913.)

The vegetable products used in perfumery are (1) the essential and distilled oils obtained from the flowers, fruit, seed, bark, leaves, and roots of odorous plants; (2) the flower pomades, enfleurage greases, concretes and floral essences obtained by extracting the odorous principles of flowers, and other aromatic substances; (3) the gums, resins, balsams, and similar odorous plant products; and (4) the natural-occurring aromatic chemicals isolated from the essential and distilled oils. The bulk of the essential oils are obtained from exotic plants by a distillation process, and since these oils, as well as the flower concentrates, essences, etc., must be prepared in close proximity to where the flowers and plants are grown they are largely

[1] See Tariff Information Survey for "Soaps" (par. 66 of act of 1913).

imported from abroad. All of the essential oils, with the single exception of oil of cajeput, are dutiable under paragraph 46 of the act of 1913, and these products are discussed in the tariff information surveys for this paragraph. Enfleurage greases and floral essences, dutiable under paragraph 49, are the subjects of a separate tariff information survey. "Natural or synthetic odoriferous or aromatic substances, preparations, and mixtures, used in the manufacture of, but not marketable as, perfumes and cosmetics," and not elsewhere specially provided for, are also dutiable under paragraph 49 and are discussed in detail in a separate unit of the tariff information surveys.

The raw materials of mineral and chemical origin include (1) odorless liquid vehicles, such as alcohol and glycerin, and the volatile solvents, such as petroleum ether, chloroform, and carbon bisulphide, which are used in extracting the aromatic principles from the plants; (2) the synthetic aromatic chemicals prepared from coal tar or other chemical products, which form the basis of the so-called synthetic or artificial perfumes; and (3) the various powders (such as talcum, starch, and chalk), greases (such as vaseline, tallow, and the fixed oils), and other similar materials used in the manufacture of cosmetic preparations.

The manufacture of synthetic aromatic chemicals forms an important branch of the perfume industry, in which prior to the war the United States was largely dependent upon Germany. With the development of the American dye industry, however, the domestic manufacture of synthetic perfumes has made great progress. The new industry produces several hundred different perfume materials, and its output of most of these products considerably exceeds the prewar imports. (For more detailed discussion, reference should be made to the tariff information survey for "Natural and synthetic perfume materials," par. 49, act of 1913, see pp. 73ff.)

The important perfume materials not elsewhere discussed are briefly described in the following paragraphs:

Alcohol, the so-called "cologne spirits," which plays an important part in the manufacture of perfumery, must be of the highest quality and entirely free from fusel oil and other impurities capable of affecting the fragrance of the final product. Since many of the essential oils and other ingredients are soluble only in strong alcohol, the perfumer requires 90 to 95 per cent or even absolute (100 per cent) alcohol. This grade of alcohol is relatively expensive (about $5 per gallon in 1920), but is essential for fine perfumery. The perfume manufacturer is not permitted by the Government to use denatured alcohol in liquid perfumery (except in hair shampoos) and must therefore pay an internal-revenue tax of $2.20 per proof gallon on all alcohol he uses. (See p. 34 for sec. 600, par. C, of the revenue act of 1918.)

Alcohol which has been properly denatured according to the regulations of the Bureau of Internal Revenue can be used in the preparation of practically all face creams, semisolid pastes, and powders for the teeth. Shampoos are the only preparations for the hair which are permitted to use denatured alcohol. No liquid mouth washes are made with denatured alcohol.

Glycerin, itself an important cosmetic, is used as the basis for most of the preparations for the care of the skin. The grade used in perfumery is known as the "C. P." (chemically pure) and is a colorless,

odorless liquid of the consistency of a thick sirup. Crude glycerin is produced on a large scale in the manufacture of soap.

Fats and *fixed oils* are used extensively in the preparation of pomades, hair oils, and various other cosmetics. For these uses it is usually necessary that the greases be thoroughly purified, so that they are odorless and will remain free from rancidity for a long time. Animal fats, such as lard and tallow; vegetable oils and greases, such as coconut, palm, olive, and castor oils; and mineral greases, such as vaseline and paraffin, are used in various cosmetical preparations.

Starch in a pure state is an important constituent in practically all face and toilet powders. It is largely used because of its fineness of grinding and because its close attachment of particles gives it good covering power and tends to make the powder stick well to the skin. Any of the various forms of starch, if sufficiently pure, can be used, but there is apparently a preference in the trade for rice starch and purified potato starch.

Precipitated chalk (calcium carbonate), magnesium carbonate, zinc oxide, zinc stearate, and bismuth white (bismuth subnitrate) are also used in toilet powders. Italian talc, a high-grade talcum, is used for the manufacture of toilet powders in preference to talc obtained from other sources. Pumice, magnesium carbonate, or some similar scouring agent forms the basis for tooth powders and pastes, and to these are added such ingredients as glycerin, menthol, alcohol, and the essential oils, which are to give the desired consistency, odor, and taste.

Almond meal and expressed almond oil are used in many of the lotions, emulsions, and vegetable milks. Cold cream and other crêmes are similar preparations, except that thick glycerin, agar-agar (Chinese gelatine), casein, wax, or spermaceti are added to give the required consistency. As in the case of practically all toilet preparations, a flower water, essential oil, or other perfume material, is added to impart desired odor or flavor.

Pyrogallic acid, tannin, and other vegetable dyes, as well as litharge and other lead, silver, and copper salts, are commonly used for coloring the hair.

Lime, sodium sulphide, barium sulphide, and similar chemical substances are used in depilatories.

Tincture of cantharides (Spanish fly) and quinine are commonly used in the so-called "hair restorers."

Castor oil and glycerin are important constituents in the so-called "brilliantines" used for imparting a gloss to the hair. The bandolines and other preparations serving to fix or stiffen the hair contain a wax, spermaceti, tragacanth, or gum arabic.

METHODS OF PRODUCTION.

The preparation of the true perfumes is a relatively simple process, although great skill and experience is often involved in obtaining the proper blending of the different materials. If the raw materials are the alcoholic extracts prepared from flower pomades or volatile-solvent concretes, they are mixed with cologne spirits in certain definite proportions, and the perfume is finished. However, it is often desirable to clarify the products, usually by allowing them to settle for some time before the final bottling. Filtration is occasionally employed, but usually at the expense of the odor.

In modern practice perfumes are usually chilled to a temperature of about 18° C. in order to remove the slight traces of fatty or resinous material held in solution by the alcohol. It is impossible, within the limitations of this report, to present the detailed technology of perfume and cosmetic manufacture. In the following paragraphs, therefore, an effort is made to describe the preparation of only a few important articles, principally those mentioned specifically in the tariff act.

The floral or *flower waters* are obtained as by-products in the steam-distillation process of preparing essential oils. The flowers are distilled with steam, and the essential oil of the flower separates from the condensed steam or water, and the water is left perfumed with the odor of the flowers. Typical examples are found in the cases of the well-known rose water and orange-flower waters. The former is produced largely in Bulgaria as a by-product in the production of attar of roses, and the latter in southern France as a by-product in the distillation of neroli, the oil of orange blossoms. True flower waters do not contain alcohol.

Eau de cologne, or *Cologne water*, is one of the most famous perfume preparations. It was first made at Cologne-on-the-Rhine by a family of Italian descent, who for a long time guarded its method of preparation as a trade secret. It was at one time believed that the genuine article made at Cologne possessed the most desirable qualities, but as the various formulæ for its preparation have become more generally known it has been demonstrated that identical preparations can be made elsewhere. An example of a formula for this product which shows the type of constituents used in its manufacture is reported by Askinson to be as follows:

Oil of bergamot	2½ ounces.
Oil of lemon (hand pressed)	6 ounces.
Oil of neroli petale	3½ ounces.
Oil of neroli bigarade	1½ ounces.
Oil of rosemary	2½ ounces.
Alcohol	30 quarts.

Bay rum, one of the important cosmetic preparations, is made from the oil obtained from the leaves and berries of the bay tree (*Myrcia aeris*). This tree grows abundantly on the islands of Jamaica, St. Thomas, Barbados, and Dominica. The oil is prepared from the fresh leaves on the spot, or they are dried and exported to this country to be distilled. The bay rum imported from the West Indies is prepared by twice distilling a form of rum (from molasses) with the bay leaves and berries. Many of the preparations known as bay rum are mixtures of bay oil and alcohol. Others contain in addition pimento, clove, and orange oils.

Sachet powders are the dry perfumes made by mixing and grinding various aromatic plants and plant products. Certain flowers retain their odorous principles after drying and are used in sachets. The principal sachet materials, however, are orris, vetiver, and calamus roots, rose, lavender, orange, and lemon-tree leaves, patchoulí herbs, sandalwood, and tonka and vanilla beans. Musk and synthetic odorous principles are also commonly added to sachet powders.

Pomades, as the term is used in the tariff act, refer to fresh fats perfumed with the flower odor and used for oiling the hair. They

may be obtained by (1) maceration of the flowers with an oil o grease; (2) by a mixture of a grease with a quantity of enfleurage grease; (3) by the addition of volatile oil to a grease; and (4) by the use of so-called washed flower pomades. Lard and beef tallow and vaseline are used for the finest hair pomades, to which are sometimes added wax, spermaceti, stearin, coconut butter, and castor oil. The cheaper pomades often contain borax, which gives the product the property of holding more water.

DOMESTIC PRODUCTION AND CONSUMPTION.

Domestic production.—According to the Census of Manufactures for 1914, the domestic production of perfumery and cosmetics has steadily increased in value from $4,630,141 in 1889 to $16,899,101 in 1914. During this period the number of establishments has increased from 157, with a total capital of $2,238,901, in 1889, to 496, with a capital of $9,646,613, in 1914. The cost of materials in 1914 was reported to be $7,464,786, indicating that the value added by manufacture in that year amounted to $9,434,315. The total number of persons engaged in the domestic perfume industry in 1914 was 5,421, who received in salaries and wages $3,748,414.

In addition to the total reported for 1914 there were also 436 establishments reporting these materials as subsidiary products, so that the total output of perfumes and cosmetics amounted in value to $19,160,407. New York, with 159 establishments and an output valued at $7,289,251, is by far the most important producing State. Illinois ranked second with 60 establishments and an output of $1,560,279. Other important producing States are shown in the table on page 24.

Domestic exports.—The exports of perfumery, cosmetics, and toilet preparations have shown a remarkable increase in recent years. From a total value of $683,253 in 1909, the exports steadily increased and in 1914 amounted to $1,620,872. With the outbreak of the European war and the partial or complete elimination of France and Germany from the world's markets, a considerable stimulus was given to the domestic industry. Exports in 1916 had risen to $2,903,063 and in 1918 to $3,965,465. During the calendar year 1919 there was a further increase of 87.5 per cent—the total export of $7,324,422 amounting to over ten times the value of the 1909 exports.

How world-wide is the trade in American-made perfumes and cosmetics is shown by the fact that in June, 1920, these products were exported to 77 countries and in July, 1920, to 66 countries. Canada and England were the principal foreign customers prior to the war and accounted for about one-half of the total. Striking increases have been made since 1914 in the exports to British India, Australia, and the Central and South American countries. French, English, and German goods formerly held a large proportion of the perfume trade in Latin America. France supplied the finer perfumes and toilet preparations, England the fine toilet soaps, and Germany specialized in cheaper perfumes and articles in popular demand. Products of American manufacture are now competing in all of these lines.

Imports.[1]—The imports of perfumery, cosmetics, and toilet preparations have likewise shown considerable increase in recent years. The general imports have increased from $1,214,792 in 1910 to $4,972,541 in 1919 (calendar year). The imports during each year since 1910, with the single exception of 1918, have shown an increase over the imports of the preceding year. France is by far the most important source of supply, furnishing from 80 to 90 per cent of the total imports. Switzerland is second in importance and England is next.

In 1913 the imports for consumption of perfumery and cosmetics containing alcohol was 285,553 pounds, valued at $818,942, yielding a revenue of $580,803. In 1917 this increased to 358,160 pounds, worth $1,084,283, on which $793,833 were collected in revenue. The quantity of the imports of nonalcoholic perfumes was not published prior to 1919, but since 1913 the value of the imports has ranged between $989,323 in 1915 and $1,833,793 in 1919. In 1919 there were included 815,130 pounds of nonalcoholic perfumes and toilet waters, valued at $1,547,995, and 613,070 pounds of cosmetical preparations, worth $285,798. The 1919 imports of alcoholic perfumery included 218,991 pounds of perfumes and cologne waters, valued at $908,641, and 18,854 pounds of cosmetic preparations, valued at $15,653. Revenue collected from nonalcoholic perfumery since 1913 has ranged between $593,593 in 1915 and $1,100,276 in 1919.

The imports of floral or flower waters, not containing alcohol, prior to 1918 had averaged about $40,000 in value. In 1919 the imports so classified increased in value to $284,648 and yielded a revenue of $56,929. Imports of bay rum have fallen off considerably during recent years. In 1908 the imports of bay rum were 1,917 proof gallons, valued at $1,504, and in 1919 only 6 gallons, valued at $19. However, imports (entered free of duty) from the Virgin Islands amounted to 594 proof gallons, valued at $700, in 1918, and to 1,377 proof gallons, valued at $2,697, in 1919. Both the bay leaves and oil are imported into this country for the production of bay rum, but import statistics are not published in Commerce and Navigation. In 1914, according to the Department of Commerce, 168,165 pounds of bay leaves, valued at $5,370, and 1,642 pounds of bay oil, valued at $2,440, were received, principally from the West Indies.

Domestic consumption.—It is difficult to arrive at an accurate figure for the domestic consumption of perfumery and cosmetics. The latest production statistics are those of the Census of Manufactures for 1914, since the result of the census for 1919 has not yet been announced (Nov. 12, 1920). Adding the 1914 production to the imports and subtracting the exports indicates that the domestic consumption at that time was in the neighborhood of $20,000,000. It is believed, however, that this approximation is considerably lower than the actual consumption.

The revenue act of 1918, in Title IX, provided an excise tax of 1 cent for each 25 cents or fraction thereof of the amount paid for perfumery, cosmetics, and toilet articles. If the collections from this

[1] General imports and imports for consumption are shown on pages 28 to 31, inclusive. The imports of perfumery, cosmetics, and toilet preparations during the fiscal year 1914 are shown in detail on page 34 of this report.

tax were shown separately by the Bureau of Internal Revenue, it would be possible to estimate the total sales of these articles with a fair degree of accuracy. However, the collections for perfumery and cosmetics are unfortunately grouped with those for medicinal articles and proprietary medicines. The preliminary statement issued by the bureau October 8, 1920, shows that the total excise tax collected on "perfumes, cosmetics, and medicinal preparations" during the fiscal year ending June 30, 1920, was $6,428,610.36. Assuming that the tax collected was 1 cent for each 25 cents of the retail value, the total sales of perfumery and medicinal articles during the year amounted to $161,000,000. This figure, however, is of little value, since it includes the sales of all medicinal preparations. It has been estimated by the editor of the American Perfumer and Essential Oil Review that the sales of perfumery and cosmetics during 1920 were probably between $80,000,000 and $100,000,000.[1]

HISTORY OF PERFUMERY.

As is the case with many others of the ancient arts, it is difficult to trace the exact origin of perfumery. The Egyptians, perhaps the most important perfumers of early civilization, carried on an extensive trade in perfumes with the Persians. The centers of the Egyptian industry were at Babylon and Alexandria, and the principal perfume materials at that time were crude drugs, herbs, aromatic resins and various woods of the Orient. From the Egyptians the use of perfumery was transmitted to the Jews, thence to the Assyrians, the Greeks, the Romans, the Arabs, and the Turks. Perfumery became a part of the religious ceremonies and the priests became adept at compounding the perfumes and incenses for their altars. These materials were generally believed to possess medicinal powers and often formed the basis of many of the ancient medicines.

The Greeks and Romans were the first to develop the use of cosmetics and creams, also of tooth powders and bath preparations. After the fall of the Roman Empire the use of perfumery was taken up by the Arabs, who are credited with having discovered the process of distillation, and therefore the method of preparing rose water and the flower essences. Perfumery had become almost obsolete in Europe, but shortly after the crusades was again revived. The crusaders brought back costly perfumes and cosmetics from the Orient and the demand created for these products gave rise to the industry in Europe. Alcoholic perfume appeared first in the thirteenth century, being introduced by Elizabeth, Queen of Hungary. Italian perfumes at the time of the Renaissance were regarded as the finest available, and it was from Italy that the preparation of perfumery passed to France, where it has since become a true national industry. There the art and science of perfumery have gained a firm foundation, and during the last half century France has become supreme in this field. The extensive cultivation of flowers in the Riviera district of southern France has given her a practical monopoly of the natural perfume industry. In the development of the synthetic or artificial industry, however, more progress was made in Germany, although manufacture developed to some extent in Switzerland, France, and the United States.

[1] See American Perfumer and Essential Oil Review for July, 1920.

Paris is the recognized center for the manufacture of the finished perfumery. London probably ranks next in importance, and New York is a close third. There are many manufacturers in Berlin and other cities of Germany, as well as in Italy and Spain, but the three cities—Paris, London, and New York—may be regarded as the three perfume centers of the world.

FOREIGN PRODUCTION.[1]

France.—The manufacture of perfumery is one of the most important industries of France. The value of the annual output is estimated to be over $30,000,000, and of this amount nearly three-fourths is exported. In 1906 there were 233 perfume factories in France, employing in all over 5,000 people.[2] Most of the factories for the finished perfumery are in or near Paris, and 65 per cent of the total personnel in 1906 were employed in that district.

The flowers from which the perfumes are made are grown on a large scale in the Department of Alpes-Maritimes in southern France. Grasse, Nice, and Cannes, three important cities of this region, are recognized as the flower centers of the world. They supply the natural raw materials for not only the Parisian industry but for perfume manufacturers all over the world. The Riviera district contains about 60 factories and in 1913 employed over 2,000 persons. The value of output of perfume materials, such as the concretes and floral essences, enfleurage greases, and flower waters, amounted to $6,000,000 in 1913.[3] The annual harvest of flowers at Grasse alone, according to Grandmougin,[4] is approximately as follows:

	Pounds.
Roses	3,650,000
Orange flowers	4,850,000
Jasmines	290,000
Violets	970,000
Tuberoses	725,000

In addition, the following essential oils are distilled on a large scale: Lavender, thyme, aspic, mint, and geranium rose.

The French flower growers, shortly before the war, organized themselves into associations or syndicates, which since that time have had considerable influence on the perfume industry. These associations consist of two types, the first of which is a syndicate including all of the growers of a certain flower, formed for the purpose of obtaining a possible monopoly of the sale of the flowers to the perfume manufacturers. The second type of syndicate is an organization of all of the growers in a certain district or village, and has for its purpose the improvement of the industry in general, but without dictating the prices of the flowers. Associations of the first type include the orange flower, lavender, and jasmine syndicates. The perfume manufacturers have also effected an organization known as "La Chambre Syndicate de la Parfumerie Française," presumably

[1] A comprehensive survey entitled "The World's Work in Perfumery" shows the contribution of perfumery and perfume materials made by practically every country of the world. This article, by J. C. Umney, appeared in a special number of The Perfumery and Essential Oil Review for June 9, 1914. An abstract is to be found in the auxiliary file of this survey.

[2] Statistics are taken from an official publication known as "Evaluation de la Production," published in Paris in 1917.

[3] See U. S. Consular Report, published as supplement to Commerce Reports, Annual Series No. 56, Nov. 14, 1917.

[4] Grandmougin, E.: L'Essor des Industries en France, p. 43, Paris (1917).

for the purposes of their mutual protection in counterbalancing the organizations of the flower growers.

The imports and exports of perfumery for France for 1912 to 1918 are shown in the tables on pages 24 and 25. The imports of both alcoholic and nonalcoholic perfumes have been very small, with an average annual value of less than $150,000. The annual exports on the other hand have totaled between $8,500,000 and $12,000,000.[1] Great Britain has been the best customer for nonalcoholic perfumery and the United States is a close second. These countries together have accounted for over one-half of the total exports. French alcoholic perfumery is most largely exported to the Latin-American countries and to the French colonies. Argentina has taken a larger proportion of the exports of alcoholic perfumery than any other country, although the quantities shipped to the United Kingdom and to the United States have increased considerably in recent years.

Great Britain.—The British perfume industry has specialized in the manufacture of fine toilet soaps, for which she has developed a large export trade. Her export trade in finished perfumery is also considerably in excess of her imports. Since 1912 Great Britain has annually imported about 1,500,000 pounds of nonalcoholic perfumery, valued at about $1,000,000, and about 20,000 gallons of alcoholic perfumery, worth approximately $375,000. On the other hand, Great Britain annually exports $1,125,000 worth of nonalcoholic perfumes and about $750,000 worth of alcoholic perfumes. In addition, Great Britain annually exports about 40,000 gallons of "spirits perfumed in bond," which are valued at approximately $500,000.

British India, Australia, Argentina, and Japan are the principal foreign customers for British perfumery.

Germany.—As previously noted, Germany's principal developments have been in the field of artificial or synthetic perfumery. However, Germany imports large quantities of essential oils and natural perfume materials for use in the manufacture of finished perfumes and cosmetics. Flower growing is carried on to some extent also, especially in the neighborhood of Leipzig, where extensive rose plantations have been established.

Germany's exports of perfumery prior to the war considerably exceeded her imports. The imports of alcoholic perfumery and toilet waters for the last six years before the war averaged about 100,000 pounds, valued at slightly less than $100,000. The annual imports of nonalcoholic perfumes averaged 100,000 pounds, valued at $13,000. and about 175,000 pounds of perfumed powders and cosmetics, valued at about $200,000, were imported each year.

The exports of Cologne water alone in 1913 amounted to slightly less than 2,000,000 pounds, valued at about $850,000. During the same year there were exported 3,460,000 pounds of other alcoholic perfumes, worth $925,000, and 1,475,000 pounds of alcoholic cosmetics, valued at $355,000. The exports of perfumery and cosmetics not containing alcohol in 1913 amounted to 1,560,000 pounds, valued at $720,000.

Before the war, Germany exported Cologne water principally to Great Britain, Netherlands, and Belgium. Her exports of other alcoholic perfumes and cosmetics went chiefly to the East Indies,

[1] This does not include essential oils, flower products, and other perfume materials.

British West Africa, China, and to South America. The principal customers for nonalcoholic perfumery in order of their importance were Great Britain, Russia, Austria-Hungary, Italy, and British West Africa.

Argentina.—Argentina is an important market for American, French, English, and German perfumery. That Argentina possesses a fair-sized domestic industry is shown by the following statistics for 1918.[1] There were 34 factories in operation and the production amounted to 552,766 quarts of Cologne and Florida water; 154,237 quarts of miscellaneous lotions; 1,425 quarts of various extracts, and 22,101 pounds of transparent soaps.

TARIFF HISTORY.

Toilet preparations, cosmetics, and nonalcoholic perfumery.—All cosmetics and toilet preparations used as applications to the hair, mouth, teeth, or skin were dutiable at 50 per cent ad valorem under the acts of 1883 and 1890. In 1894 the rate was reduced to 40 per cent ad valorem and the provision was expanded to include "articles of perfumery n. s. p. f." The 50 per cent rate was restored in 1897 and the distinction between alcoholic and nonalcoholic perfumery was more clearly made by the insertion of the words "not containing alcohol or in the manufacture of which alcohol is not used." The act of 1909 further increased the rate on nonalcoholic perfumery to 60 per cent ad valorem and this rate was continued by the act of 1913.

Alcoholic perfumery.—Alcoholic perfumery, including Cologne water, was dutiable at $2 per gallon and 50 per cent ad valorem under the acts of 1883 and 1890. In 1890 the provision was enlarged to include "other toilet waters." The rate and phraseology were unchanged by the act of 1894. In 1897 the words "and toilet preparations of all kinds, containing alcohol or in the preparation of which alcohol is used," were added and the rate was changed to 60 cents per pound and 45 per cent ad valorem. In the act of 1909 the provisions for alcoholic and nonalcoholic perfumery were combined in a single paragraph, and a duty of 60 cents per pound and 50 per cent ad valorem was provided for alcoholic perfumery. In 1913 this rate was changed to 40 cents per pound and 60 per cent ad valorem and the qualifying provision "or in the manufacture or preparation of which alcohol is used" was omitted. The change in 1913 had the effect of admitting at the lower rate of duty the large number of cosmetics and toilet preparations not containing alcohol, but in which alcohol had been used (usually as a solvent) in some step in the manufacturing process.

Floral or flower waters.—The provision for nonalcoholic floral or flower waters was added to paragraph 67 of the act of 1909 presumably because of the large amount of litigation occasioned by the classification of these articles under previous tariff acts. The rate provided in 1909 was 20 per cent ad valorem and the provision was not changed by the act of 1913.

Bay rum.—The act of 1883 provided a duty of $1 per gallon for bay rum or bay water of first proof and in proportion for any greater

[1] "Manufacture of Toilet Articles in Argentina," by P. S. Smith, Trade Commissioner, Department of Commerce; received Oct. 5, 1920.

strength than first proof.[1] The duty was increased to $1.50 per gallon by the act of 1890, and again made $1 by the act of 1894. The act of 1897 restored the rate to $1.50 per gallon, which was increased to $1.75 by the act of 1909. This rate was not changed by the act of 1913.

TARIFF CONSIDERATIONS.

Internal-revenue tax on alcohol and compensatory duties.—The alcohol used in the manufacture of perfumery, whether produced in or imported into the United States, is subject to an internal-revenue tax of $2.20 per proof gallon (or per wine gallon when below proof), which is the rate provided in section 600, paragraph (a), of the revenue act of 1918, approved February 24, 1919. This is the same rate as was provided in section 300 of the revenue act of 1917, approved October 3, 1917. The internal-revenue tax on alcohol for nonbeverage purposes prior to October 3, 1917 (and at the time of the passage of the tariff act of 1913), was $1.10 per proof gallon.

When Congress, in the revenue act of 1917, increased the internal-revenue tax on alcohol it imposed a compensatory duty on imports of alcoholic perfumery. Section 300, paragraph (c), of the revenue act of 1917 provided for an additional duty of $1.10 per wine gallon and a proportionate tax on all perfumes containing distilled spirits, which are imported into the United States subsequent to the date of passage of that act. The same rate was carried over in section 600, paragraph (c), of the revenue act of 1918.

In past tariff acts Congress levied a specific duty on alcoholic perfumery in addition to the ad valorem rate, presumably for the purpose of counterbalancing the internal-revenue tax paid on the alcohol used by the domestic manufacturers. Perfumes and toilet waters vary widely in alcoholic content, and it is obvious that a specific rate of duty which would exactly counterbalance the internal-revenue tax on the alcohol in a perfume containing 90 per cent of alcohol would be excessive on a toilet water containing only 10 per cent of alcohol. However, a specific rate per proof gallon of alcohol actually contained, or different specific rates based on alcoholic content, would involve serious administrative difficulties. Chemical analysis would be required for practically every shipment, since there are comparatively few articles of standardized alcoholic content.

A gallon of imported perfumery containing 90 per cent of alcohol must pay a specific duty of approximately $3.20 under paragraph 48 of the act of 1913 plus $1.10 under section 600 of the act of 1918, making a total duty of $4.30 in addition to the ad valorem rate of 60 per cent. The internal-revenue tax paid by the domestic manufacturer on the alcohol used in a gallon of the same perfume, under section 600 of the act of 1918, is $3.96.

The specific duty on a gallon of imported perfumery containing but 10 per cent of alcohol is the same as that on the 90 per cent article, viz., $3.20 under the act of 1913, and $1.10 under the act of 1918. The internal-revenue tax on the alcohol contained in such a preparation, however, is only 44 cents.

[1] "Proof spirit shall be held to be that alcoholic liquor which contains one-half its volume of alcohol of a specific gravity of seven thousand nine hundred and thirty-nine ten-thousandths (0.7939) at sixty degrees Fahrenheit." (Sec. 3249, Revised Statutes.)

Duties on bottles.—When perfumery is imported in plain glass bottles, the containers, by the operation of paragraph 83, are subject to the same ad valorem rate of duty as their contents, namely, 60 per cent. If, however, the perfumery is put up in cut or decorated bottles the containers are separately dutiable at the lower rate of 45 per cent ad valorem under paragraph 84. (See Abstracts 41682 and 41692 of 1918.)

Revenue considerations.—Perfumery and cosmetics under past tariff acts have been important sources of revenue and have generally borne rates of duty somewhat higher than those imposed on other dutiable commodities. In the following table is shown the average annual revenue yielded by perfumery under the different tariffs since 1883. It will be noted that during the period 1914–1919 the imports of perfumery and cosmetics yielded an average annual revenue of over one and one-half million dollars.

Average annual revenue derived from imports of perfumes and cosmetics, 1883–1919.

Tariff act of—	Period covered in averages (fiscal years).	Alcoholic perfumery.		Nonalcoholic perfumery.	
		Average annual revenue.	Equivalent ad valorem rate of duty.	Average annual revenue.	Equivalent ad valorem rate of duty.
			Per cent.		*Per cent.*
1883	1884–1889	$143,103	62.60	$61,285	50.00
1890	1890–1894	163,197	62.30	83,406	50.00
1894	1895–1897	214,311	63.75	117,110	40.00
1897	1898–1909	326,529	68.50	181,385	50.00
1909	1910–1913	507,465	71.30	492,156	60.00
1913	1914–1919	643,944	72.75	885,573	60.00

In addition to the revenue derived from imports, the revenue act of 1918 provided for an excise—or so-called "luxury"—tax on sales of perfumes, cosmetics, and toilet preparations at the rate of 1 cent for each 25 cents or fraction thereof of the retail price.[1] Separate statistics showing the revenue derived from sales of perfumery are not available, but for the fiscal year ended June 30, 1920, the Bureau of Internal Revenue collected $6,428,610.36 as excise taxes on "Perfumes, cosmetics, and medicinal articles."

Statistical Data.

Perfumery and cosmetics—Production in United States.

[From Federal Census.]

Year.	Number of establishments.	Value.	Year.	Number of establishments.	Value.
1899	262	$7,088,000	1909	429	$14,212,000
1904	292	11,133,000	1914	496	[2] 16,899,000

[1] Portions of sec. 907 of the revenue act of 1918, imposing excise taxes on the sales of perfumery, are shown on p. 34.

[2] In addition there were 436 establishments producing perfumery as subsidiary products and their output brings the total for 1914 to $19,160,407.

Perfumery and cosmetics—Production in United States, by States.

State.	1914		State.	1914	
	Number of establishments.	Value of product.		Number of establishments.	Value of product.
California	16	$154,799	Missouri	22	$533,316
Colorado	4	45,786	New York	159	7,289,251
Illinois	60	1,560,279	Ohio	28	830,893
Indiana	15	79,362	Oklahoma	3	22,900
Iowa	8	444,303	Pennsylvania	41	686,735
Kansas	8	60,103	Rhode Island	4	17,206
Kentucky	4	51,601	Tennessee	11	231,772
Louisiana	4	126,189	Texas	7	66,536
Maryland	11	286,798	Wisconsin	4	259,824
Massachusetts	16	1,135,133	All other	35	2,067,265
Michigan	25	824,096			
Minnesota	11	124,954	Total	496	16,899,101

French imports and exports of perfumery.

Years.	Alcoholic perfumes.				Nonalcoholic perfumes.			
	Imports.		Exports.		Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*		*Gallons.*	
1912	9,140	$37,442	497,696	$2,036,150	302,912	$99,395	7,352,562	$2,188,427
1913	6,974	28,564	448,376	1,834,465	266,756	87,622	6,667,372	1,984,426
1914	4,676	19,107	298,248	1,307,382	181,076	56,163	4,981,074	1,569,862
1915	660	3,619	238,916	1,309,119	128,748	53,538	5,547,215	2,136,896
1916	819	5,983	345,692	2,555,899	169,313	87,815	6,743,650	3,244,716
1917	634	6,948	299,648	5,473,094	225,310	157,874	5,576,094	7,224,569
1918	291	3,281	280,918	5,130,905	109,789	76,814	2,803,810	3,632,839

French exports of perfumes other than toilet soaps, 1912–1917.

[Source: Tableau General du Commerce et de la Navigation, Vol. I.]

Country.	1912.		1913.		1914.	
	Alcoholic.	Nonalcoholic.	Alcoholic.	Nonalcoholic.	Alcoholic.	Nonalcoholic.
	Gallons.	*Pounds.*	*Gallons.*	*Pounds.*	*Gallons.*	*Pounds.*
Great Britain	51,540	1,726,863	56,849	1,888,240	39,044	1,368,395
Germany	23,009	652,562	14,635	589,069	10,223	287,480
Belgium	38,569	766,319	35,504	770,067	16,114	328,485
Spain	6,076	57,761	4,755	57,320	4,068	75,177
Austria-Hungary	5,917	66,579	5,812	40,565	3,725	.....
Italy	8,401	157,849	6,763	156,526	5,997	164,243
Turkey	12,495	58,422	11,571	39,242	10,118	196,209
Egypt	8,031	.....	7,582	.....	6,816	.....
United States	32,969	1,606,492	32,466	1,104,945	29,112	1,225,758
Mexico	12,442	276,457	12,601	227,956	3,196	21,385
Colombia	22,243	163,361	17,541	140,212	12,257	61,508
Brazil	29,719	248,238	20,922	140,433	12,020	103,396
Uruguay	9,193	.....	10,355	59,745	4,412	42,990
Argentina	103,264	386,246	69,979	357,586	40,946	234,129
Canada	9,959	.....	11,833	65,477	5,019	23,148
Haiti	6,974	.....	3,170	.....	1,189	.....
French colonies	62,793	272,268	54,578	297,180	44,592	248,238
All other	54,102	913,145	71,960	732,809	49,400	600,533
Total	497,696	7,352,562	448,376	6,667,372	298,218	4,981,074

French exports of perfumes other than toilet soaps, 1912–1917—Continued.

Country.	1915		1916		1917	
	Alcoholic.	Non-alcoholic.	Alcoholic.	Non-alcoholic.	Alcoholic.	Non-alcoholic.
	Gallons.	*Pounds.*	*Gallons.*	*Pounds.*	*Gallons.*	*Pounds.*
Great Britain	34,712	1,591,280	34,421	1,415,133	23,802	1,184,532
Spain	5,732	106,041	5,838	173,061	7,397	152,999
Italy	6,631	150,574	10,990	284,393	7,793	179,895
Egypt	5,706	55,115	9,272	.....	9,431	31,746
United States	38,437	1,799,174	48,951	2,037,932	57,483	2,391,991
Mexico	.....	.....	.....	.....	.....	71,650
Colombia	9,061	64,595	12,759	97,664	5,997	78,484
Brazil	9,589	284,614	17,620	294,755	11,650	146,606
Uruguay	2,959	.....	6,736	.....	6,472	33,510
Argentina	32,097	375,664	47,709	461,643	35,610	271,607
Canada	.....	.....	.....	.....	2,378	.....
Haiti	.....	.....	.....	53,351	.....	.....
French colonies	37,295	170,416	49,664	289,684	48,237	137,567
All other	56,295	949,742	101,732	1,636,034	83,398	895,509
Total	238,916	5,547,215	345,692	6,743,650	299,648	5,576,094

French imports of perfumes other than toilet soaps, 1912–1917.

Country.	1912		1913		1914	
	Alcoholic.	Non-alcoholic.	Alcoholic.	Non-alcoholic.	Alcoholic.	Non-alcoholic.
	Gallons.	*Pounds.*	*Gallons.*	*Pounds.*	*Gallons.*	*Pounds.*
Great Britain	7,661	92,152	5,574	80,688	3,857	52,469
Germany	1,083	32,187	1,004	32,849	476	22,707
Switzerland	.....	2,205	.....	1,102	.....	661
Spain	.....	22,267	.....	.....	.....	.....
Bulgaria	.....	51,147	.....	.....	.....	25,132
Turkey	.....	40,344	.....	32,628	.....	24,030
United States	.....	42,108	.....	53,351	.....	31,526
French colonies	26	220	53	882	53	2,646
All other	370	20,282	343	65,256	290	11,905
Total	9,140	302,912	6,974	266,756	4,676	171,076

Country.	1915		1916		1917	
	Alcoholic.	Non-alcoholic.	Alcoholic.	Non-alcoholic.	Alcoholic.	Non-alcoholic.
	Gallons.	*Pounds.*	*Gallons.*	*Pounds.*	*Gallons.*	*Pounds.*
Great Britain	528	72,090	687	130,292	528	198,855
Switzerland	26	882	.....	.....	.....	.....
Spain	.....	.....	.....	2,425	.....	1,984
United States	106	52,690	106	34,612	79	23,810
French colonies	.....	.....	26	441	.....	.....
All other	.....	3,086	.....	1,543	27	661
Total	660	128,748	819	169,313	634	225,310

German exports of perfumery.

Year.	Cologne water.		Other alcoholic perfumes.[1]		Alcoholic cosmetics.[2]		Perfumes and cosmetics not containing alcohol.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1908	457,895	$128,628	2,133,171	$691,495	509,924	$192,942	742,289	$267,737
1909	434,747	131,486	2,248,872	728,892	641,759	242,726	835,764	335,147
1910	1,386,693	404,464	2,960,116	959,470	889,336	336,338	967,819	399,938
1911	1,859,360	696,497	3,135,823	870,859	1,265,881	332,289	1,145,290	504,031
1912	1,959,008	779,152	2,883,396	840,846	1,123,244	316,330	1,340,397	550,480
1913	1,979,730	841,561	3,459,238	926,360	1,476,862	354,680	1,561,298	721,508

[1] Other ether or alcohol containing perfumes and toilet waters.
[2] Mouth, hair, and teeth preparations containing ether or alcohol.

German exports of perfumery, by countries, 1913.

Country.	Cologne water.		Other alcoholic perfumes.		Alcoholic cosmetics.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Belgium	89,507	$40,494	.....	.....	34,171	$15,483
Great Britain	513,010	259,638	27,998	$17,150	.....	.....
Italy	43,431	19,056	.....	.....	86,961	41,685
Netherlands	151,897	65,505	.....	.....	81,129	31,681
Austria-Hungary	24,692	13,101	16,755	19,771	.....	.....
Russia	34,171	18,103	54,013	86,467	.....	.....
France	.....	.....	23,810	13,816	.....	.....
Turkey	40,123	8,099	104,057	23,820	.....	.....
China	.....	.....	181,659	45,734	.....	.....
East Indies	.....	.....	798,065	108,143	761,469	104,570
Argentina	47,398	22,153	23,810	13,101	.....	.....
Brazil	.....	.....	32,849	26,202	.....	.....
Chile	.....	.....	15,212	15,721	.....	.....
Cuba	.....	.....	38,140	15,249	.....	.....
Uruguay	.....	.....	58,863	15,007	.....	.....
British West Africa	.....	.....	664,466	72,889	.....	.....
Panama	.....	.....	63,492	12,148	.....	.....
Mexico	.....	.....	21,385	20,247	.....	.....
All other	1,035,501	395,412	1,334,664	420,895	513,232	161,261
Total	1,979,730	841,561	3,459,238	926,360	1,476,862	354,680

German exports of nonalcoholic perfumes, cosmetics, toilet waters, etc., 1913.

Country.	Quantity.	Value.	Country.	Quantity.	Value.
	Pounds.			*Pounds.*	
Belgium	43,651	$19,294	British West Africa	98,546	$19,771
Denmark	31,967	13,339	British West India	57,320	8,099
France	25,353	17,627	China	30,644	12,148
Great Britain	154,322	84,323	Argentina	72,752	33,348
Italy	108,466	53,119	Brazil	25,794	12,386
Netherlands	65,918	26,202	United States	65,697	28,584
Austria-Hungary	112,435	58,597	Australia	27,558	15,483
Russia	135,362	111,239	All other	411,597	168,884
Switzerland	50,706	25,964			
Turkey	43,210	13,101	Total	1,561,298	721,508

German imports of perfumery.

	Cologne water and other perfumery and cosmetics (e. g., hair dyes, face washes, and toilet preparations) containing ether or alcohol; head, mouth, or tooth washes containing ether or alcohol; perfumed or fragrant extracts (essences and tinctures), waters containing alcohol or ether, and toilet vinegar.		Perfumed waters, not containing alcohol or ether.		Perfumed powder, rouge, and tooth powder; tooth paste, fumigating paper, rouge paper, and all other perfumery and cosmetics, n. s. p. f.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
1908	113,300	$87,584	108,000	$11,662	149,900	$142,324
1909	110,500	84,014	114,900	12,852	172,200	167,314
1910	100,100	73,304	95,200	10,710	190,700	185,402
1911	106,500	76,874	102,500	11,662	193,300	187,782
1912	116,600	90,678	114,600	14,042	208,700	209,678
1913	117,900	94,010	114,600	14,280	248,000	248,948

British imports and exports of perfumery.

[Source: Annual statement of the trade of the United Kingdom.]

	Imports.				Exports.[3]		Spirits perfumed in bond.	
	Nonalcoholic.[1]		Alcoholic.[2]		Nonalcoholic.	Alcoholic.[4]		
	Quantity.	Value.	Quantity.	Value.			Quantity.	Value.
	Pounds.		*Gallons.*				*Gallons.*	
1912	1,169,320	$604,702	40,672	$515,489	$894,099	$815,893	47,767	$514,705
1913	1,580,259	854,815	39,858	540,084	993,472	819,519	53,643	544,362
1914	1,500,933	761,802	22,847	335,920	981,155	649,133	42,004	411,224
1915	3,041,944	255,269	12,223	237,894	1,143,214	570,733	41,363	394,454
1916	2,563,681	1,473,708	11,929	268,271	1,840,301	918,844	54,895	684,517
1917	1,044,295	864,407	7,054	297,655	1,504,148	883,722	34,749	505,712
1918	787,217	996,070	7,598	263,857	1,582,805	1,020,082	30,487	605,787

[1] Perfumery and articles used in the manufacture thereof, except perfumed spirits and essential oils.
[2] Perfumed spirits in bottles and casks.
[3] Quantity not shown.
[4] Not including "spirits perfumed in bond."

British exports of perfumery, by countries, 1913 and 1918.

Country.	1913		1918	
	Alcoholic.	Nonalcoholic.	Alcoholic.	Nonalcoholic.
France	$94,220	$31,107	$988	$60,997
Germany	.....	40,660	.....	.....
United States	.....	32,270	.....	35,827
Belgium	.....	23,096	.....	2,438
Italy	14,439	17,310	229	998
Russia	32,440	43,380	.....	.....
Japan	42,674	17,729	136,111	30,803
China	19,188	17,339	17,456	24,581
Argentina	55,055	33,944	26,454	11,748
Brazil	10,823	.....	33,949	.....
Uruguay	12,857	.....	.....	.....
British India	135,834	152,594	181,277	384,278
Australia	86,682	162,337	63,722	133,391
New Zealand	22,040	38,601	19,690	52,595
Cape Good Hope	25,880	44,300	37,925	59,323
Straits Settlements	30,678	22,225	55,678	49,448
Gold Coast	30,644	37,579	16,590	38,470
Canada	18,069	20,420	4,643	30,148
All other	188,038	258,581	425,370	667,860
Total	819,561	993,472	1,020,082	1,582,805

IMPORTS INTO THE UNITED STATES.

Perfumeries, cosmetics, and all toilet preparations (dutiable)—Imports, by countries.

[Par. 48, act of 1913.]

Imported from—	1909	1910	1911	1012	1913	1914
Austria-Hungary	$2,836	$5,283	$3,790	$5,618	$4,433	$13,240
Belgium	1,313	856	2,164	2,059	2,382	4,729
France	1,265,975	1,044,306	1,353,036	1,442,067	1,686,320	1,856,624
Germany	60,847	73,553	58,450	82,635	74,385	190,626
Italy	9,151	7,920	9,090	9,626	9,659	14,236
Russia	730	3,858	2,101	1,572	1,930	2,512
England	66,115	56,459	82,199	74,543	62,475	80,638
Cuba	1,575	2,038	832	1,432	1,479	1,845
Japan	14,065	15,967	18,539	20,649	24,497	22,776
Turkey	377	497	596	1,068	836	882
All other	2,629	4,055	3,740	4,723	5,189	120,919
Total	1,425,613	1,214,792	1,534,537	1,645,992	1,873,585	2,309,027

Imported from—	1915	1916	1917	1918	1918 [1]	1919 [1]
Austria-Hungary	$1,244	$141	.....	.....	.....	$302
Belgium	186	.....	.....	.....	.....	.....
France [2]	1,962,701	2,617,777	$3,357,235	$3,117,036	$2,885,265	4,536,595
Germany	187,510	20,011	.....	.....	.....	1,703
Italy	16,176	20,793	10,219	14,831	9,222	6,759
Netherlands	35,558	80,334	23,975	23,432	9,134	16,449
Russia	1,183	.....	.....	.....	.....	.....
Spain	2,238	6,466	9,451	4,725	3,032	4,401
Sweden	356	6,225	15,499	1,263	.....	.....
Switzerland	131,170	184,806	144,884	201,230	146,149	238,269
England	57,550	90,513	199,589	73,426	75,560	79,830
Cuba	1,137	1,862	3,820	8,674	10,437	4,496
Japan	26,709	34,794	34,950	47,849	37,157	74,078
Turkey	878	48	.....	.....	.....	.....
All other	48,548	42,136	7,077	5,229	3,793	9,659
Total	2,473,144	3,105,906	3,806,699	3,497,695	3,179,749	4,972,541

[1] Calendar years.

[2] From France, 80 per cent in 1915; 85 per cent in 1916; 88 per cent in 1917; 90 per cent in 1918.

Perfumery, cosmetics, and all toilet preparations [1] *(free)—Imports, by countries.*

Imported from—	1911	1912	1913	1914	1915	1916	1917
Philippine Islands	$550	$45	$4,522	$197	$398	$4,407	$15,200

[1] Included in "all others" in 1910.

Perfumery, including cologne and other toilet waters, articles of perfumery, whether in sachets or otherwise, and all preparations used as applications to the hair, mouth, teeth, or skin, such as cosmetics, dentifrices, including tooth soaps, pastes, including theatrical greases, paints, and pastes, pomades, powders, and other toilet preparations (not containing alcohol)—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1908	50 per cent		$604,258	$302,129		50
1909	do		706,289	353,144		50
1910	do		54,216	27,108		50
	60 per cent		539,603	323,761		60
1911	do		798,586	479,151		60
1912	do		872,478	523,486		60
1913	do		1,025,200	615,120		60
1914	do		1,084,174	650,504		60
1915	do		989,323	593,593		60
1916	do		1,269,865	761,919		60
1917	do		1,688,256	1,012,953		60
1918	do		1,490,324	894,194		60
1919 [1]	do		1,833,793	1,100,276		60

[1] In 1919 there were included 815,130 pounds of perfumes, toilet waters, etc., valued at $1,547,995, and 613,070 pounds of cosmetic preparations valued at $285,798.

Perfumery, including cologne and other toilet waters, etc. (not containing alcohol)—Imports for consumption—Revenue.

FROM PHILIPPINE ISLANDS. (Acts of Aug. 5, 1909, and Oct. 3, 1913.)

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	Free		$125			
1911	do		550			
1912	do		45			
1914	do		197			
1916	do		47			
1917	do		12,400			
1918	do		7,178			
1919	do					

FROM CUBA. (Reciprocity treaty, Dec. 27, 1903.)

1908	50 per cent less 20 per cent.		$1,302	$521		40.00
1909	do		1,315	526		40.00
1910	do		142	57		40.00
	60 per cent less 20 per cent.		1,618	776		48.00
1911	do		537	257		48.00
1912	do		1,251	600		48.00
1913	do		1,168	560		48.00
1914	do		1,333	640		48.00
1915	do		1,032	495		48.00
1916	do		1,702	816		48.00
1917	do		2,283	1,095		48.00
1918	do		5,205	2,498		48.00
1919	do	3,009	2,636	1,265		48.00

Perfumery, including cologne and other toilet waters, articles of perfumery, whether in sachets or otherwise, and all preparations used as applications to the hair, mouth, teeth, or skin, such as cosmetics, dentifrices, including tooth soaps, pastes, including theatrical greases, paints and pastes, pomades, powders, and other toilet preparations (containing alcohol)—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	60 cents per pound plus 45 per cent.	175,442	$484,498	$323,289	$2.76	66.73
1909	do	244,183	694,270	458,932	2.84	66.10
1910	do	16,146	38,247	26,899	2.37	70.33
	60 cents per pound plus 50 per cent.	192,524	544,263	387,647	2.83	71.22
1911	do	245,532	709,632	502,135	2.89	70.76
1912	do	271,838	738,549	532,377	2.72	72.08
1913	do	285,553	818,942	580,803	2.87	70.92
1914	do	73,257	198,974	143,441	2.72	72.09
	40 cents per pound plus 60 per cent.	226,763	572,367	434,125	2.53	75.85
1915	do	240,036	689,514	519,722	2.87	73.92
1916	do	281,001	828,591	609,555	2.94	73.57
1917	do	358,160	1,084,283	793,833	3.02	73.21
1918	do	265,678	1,011,659	713,266	3.80	70.50
1919 [1]	do	237,845	924,294	649,714	3.88	70.25

[1] In 1919 included 218,991 pounds of perfumes, cologne waters, etc., valued at $908,641 and 18,854 pounds of cosmetic preparations valued at $15,653.

Perfumery, including cologne and other toilet waters, etc. (containing alcohol)—Imports for consumption—Revenue.

FROM PHILIPPINE ISLANDS. (Acts of Aug. 5, 1909, and Oct. 3, 1913).

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				
1913	Free	331	$522		$1.58	
1915	do		398			

FROM CUBA. (Reciprocity treaty, Dec. 27, 1903.)

1908	60 cents per pound plus 45 per cent less 20 per cent.	52	$11	$29	$0.20	267.00
1909	do	46	8	25	.19	289.03
1910	do	12	2	6	.16	324.00
	60 cents per pound plus 50 per cent less 20 per cent.	100	18	55	.18	306.67
1911	do	7	20	11	2.69	57.87
1912	do	63	92	67	1.45	73.07
1913	do	141	239	163	1.70	68.23
1914	do	33	9	19	.27	216.00
	40 cents per pound plus 60 per cent less 20 per cent.	1,388	407	640	.29	157.07
1915	do	39	18	21	.46	117.33
1916	do	386	136	188	.35	138.82
1917	do	1,040	1,086	854	1.04	78.64
1918	do	2,055	2,988	2,091	1.45	70.01
1919	do	2,521	2,995	2,344	1.19	75.00

Bay rum or bay water, whether distilled or compounded—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Proof gallons.				*Per cent.*
1908	$1.50 per proof gallon.	1,917	$1,504	$2,876	$0.78	191.25
1909	do	290	279	435	.96	156.26
1910	do	128	86	192	.67	223.26
	$1.75 per proof gallon.	532	553	932	1.04	16.85
1911	do	675	656	1,182	.97	180.20
1912	do	375	396	657	1.05	166.14
1913	do	684	707	1,198	1.03	169.51
1914	do	483	619	845	1.28	136.42
1915	do	503	673	880	1.34	130.79
1916	do	335	341	586	1.02	171.92
1917	do	249	278	435	1.12	156.74
1918	do	46	94	80	2.04	85.64
1919	do	6	19	11	3.17	55.20
STATISTICS FROM CUBA. (Reciprocity treaty, Dec. 27, 1903.)						
1909	$1.50 per proof gallon less 20 per cent.	1	$1	$1	$1.00	120.00
1912	$1.75 per proof gallon less 20 per cent.	3	2	4	.66	210.00
1918	do	1	2	1	2.00	70.00
1919	do					
STATISTICS FROM VIRGIN ISLANDS. (Act of Mar. 3, 1917.)						
1918	Free	594	$700		$1.18	
1919	do	1,377	2,697		1.96	

Floral or flower waters containing no alcohol, n. s. p. f.—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1908	20 per cent		$18,851	$3,770		20.00
1909	do		21,736	4,347		20.00
1910	do		30,018	6,003		20.00
1911	do		26,737	5,347		20.00
1912	do		37,187	7,437		20.00
1913	do		31,710	6,342		20.00
1914	do		50,297	10,059		20.00
1915	do		22,216	4,443		20.00
1916	do		34,461	6,892		20.00
1917	do		29,279	5,855		20.00
1918	do		52,208	10,441		20.00
1919	do		284,648	56,929		20.00

Perfumeries, cosmetics, and all toilet preparations—Domestic exports.

[Par. 48, act of 1913.]

Exported to—	1909	1910	1911	1912	1913	1914
France	$14,958	$20,972	$42,412	$31,126	$42,273	$37,078
Germany	11,336	6,093	9,460	5,031	13,410	13,515
Gibraltar	11,077	8,216	10,637	9,075	11,214	10,794
England	90,835	125,450	174,736	247,874	283,963	340,845
Canada	119,547	172,608	203,648	231,474	312,401	343,402
Mexico	19,788	25,510	22,496	26,482	38,035	22,030
Cuba	18,900	24,372	31,624	43,560	42,464	41,983
Brazil	19,521	21,616	18,887	17,779	21,392	15,818
Peru	33,910	49,435	48,369	51,715	46,231	44,791
China	15,234	18,864	29,292	17,500	26,368	22,648
British India	26,701	8,153	9,373	23,128	41,592	22,715
Hongkong	19,940	15,396	22,053	28,080	22,944	22,041
Japan	10,959	10,698	30,780	6,348	23,071	16,505
Australia and Tasmania	62,342	34,046	31,774	37,264	71,416	96,499
Philippine Islands	24,568	50,643	40,896	63,213	52,160	107,924
Canary Islands	5,050	7,276	12,251	12,785	17,716	16,063
All other	179,587	225,112	270,671	295,196	375,332	446,221
Total	683,253	824,460	1,009,359	1,147,630	1,441,982	1,620,872

Exported to—	1915	1916	1917	1918	1918 [1]	1919 [1]
Denmark	$10,287	$27,183	$31,876	$3,961	$18,921	$168,830
France	25,304	67,368	34,741	97,121	12,882	14,299
Germany	1,746	.....	.....	.....	.....	354
Gibraltar	11,129	8,299	6,764	5,621	96	12,684
Spain	6,601	26,119	28,502	22,204	32,777	76,474
England	465,319	870,391	719,977	134,548	93,144	971,150
Canada	291,597	377,707	497,124	431,494	317,461	535,458
Mexico	10,864	28,523	110,117	145,912	143,890	224,448
Cuba	64,940	154,053	172,902	295,141	350,140	519,016
Brazil	20,224	75,289	133,350	216,411	205,172	305,985
Peru	22,170	59,276	108,710	138,345	157,240	157,789
China	30,816	42,086	73,535	110,752	143,716	410,625
British India	22,907	65,179	108,953	379,418	376,338	251,516
Hongkong	22,262	36,773	17,832	42,005	44,119	121,492
Japan	5,409	21,005	23,961	38,659	60,847	191,898
Australia	149,440	193,038	285,622	460,507	315,442	536,702
Philippine Islands	149,216	106,578	173,405	243,608	282,178	535,284
South Africa	60,937	108,973	132,290	232,365	221,042	299,639
All other	343,891	635,223	958,959	967,384	1,127,265	1,990,779
Total	1,715,059	2,903,063	3,618,620	3,965,465	3,902,670	7,324,422

[1] Calendar years.

Perfumery, cosmetics, and other toilet preparations—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	99	Proprietary preparations, to wit: All cosmetics, * * * pastes, drops, waters, essences, * * * or preparations or compositions recommended to the public as proprietary articles, or prepared according to some private formula, * * * including all toilet preparations whatever, used as applications to the hair, mouth, teeth, or skin, not specially enumerated or provided for in this act.	50 per cent ad valorem.
	100	Alcoholic perfumery, including Cologne water	$2 per gallon and 50 per cent ad valorem.
1890	77	Preparations used as applications to the hair, mouth, teeth, or skin, such as cosmetics, dentifrices, pastes, pomades, powders, and tonics, including all known as toilet preparations, not specially provided for in this act.	50 per cent ad valorem.
	8	Alcoholic perfumery, including Cologne water and other toilet waters.	$2 per gallon and 50 per cent ad valorem.
1894	61	Preparations used as applications to the hair, mouth, teeth, or skin, such as cosmetics, dentifrices, pastes, pomades, powders, and all toilet preparations, and articles of perfumery, not specially provided for in this act.	40 per cent ad valorem.
	7	Alcoholic perfumery, including Cologne water and other toilet waters, * * *, not specially provided for in this act.	$2 per gallon and 50 per cent ad valorem.

Perfumery, cosmetics, and other toilet preparations—Rates of duty—Continued.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	70	Preparations used as applications to the hair, mouth, teeth, or skin, such as cosmetics, dentifrices, pastes, pomades, powders, and other toilet articles, and articles of perfumery, whether in sachets or otherwise, not containing alcohol or in the manufacture of which which alcohol is not used, and not specially provided for in this act.	50 per cent ad valorem.
	2	All alcoholic perfumery, including Cologne water and other toilet waters and toilet preparations of all kinds, containing alcohol or in the manufacture of which alcohol is used * * *, not specially provided for in this act.	60 cents per pound and 45 per cent ad valorem.
1909	67	Perfumery, including Cologne and other toilet waters, articles of perfumery, whether in sachets or otherwise, and all preparations used as applications to the hair, mouth, teeth, or skin, such as cosmetics, dentifrices, including tooth soaps, pastes, including theatrical grease paints and pastes, pomades, powders, and other toilet articles, all the foregoing: if containing alcohol, or in the manufacture or preparation of which alcohol is used.	60 cents per pound and 50 per cent ad valorem.
		If not containing alcohol, or in the manufacture or preparation of which alcohol is not used.	60 per cent ad valorem.
1913	48	Perfumery, including Cologne and other toilet waters, articles of perfumery, whether in sachets or otherwise, and all preparations used as applications to the hair, mouth, teeth, or skin, such as cosmetics, dentifrices, including tooth soaps, pastes, including theatrical grease paints, and pastes, promades, powders, and other toilet preparations all the foregoing, if containing alcohol.	40 cents per pound and 60 per cent ad valorem.
		If not containing alcohol.....	60 per cent ad valorem.

Bay rum or bay water—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1883	315	Bay rum or bay water, whether distilled or compounded, * * * of first proof, and in proportion for any greater strength than first proof.	$1 per gallon.
1890	334	.....do.....	$1.50 per gallon.
1894	242	Bay rum or bay water, whether distilled or compounded, of first proof, and in proportion for any greater strength than first proof.	$1 per gallon.
1897	294	.....do.....	$1.50 per gallon.
1909	305	.....do.....	$1.75 per gallon.
1913	242	.....do.....	Do.

Floral or flower waters—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1909	67	Floral or flower waters containing no alcohol, not specially provided for in this section.	20 per cent ad valorem.
1913	48	.....do.....	Do.

MISCELLANEOUS DATA.

IMPORTS OF PERFUMERY IN 1914.

The imports of perfumery, cosmetics, and toilet preparations were published in detail for the fiscal year 1914 by Dr. E. R. Pickrell in Miscellaneous Series No. 82, Bureau of Foreign and Domestic Commerce (1919), pages 135–138. The principal articles shown under this classification are as follows:

Articles.	Value.	Articles.	Value.
Floral essences, nonalcoholic	$376,904	Not containing alcohol—Continued.	
Containing alcohol:		Nail preparations—	
Cologne water	6,105	Paste	$5,489
Dental preparations	7,215	Polishing paper	227
Essences	106,674	Polishing stones	1,686
Extracts	283,468	Powder	1,688
Hair preparations—		Toilet preparations—	
Dye and quinine	3,024	Cosmetics	9,358
Oil and brilliantine	5,110	Face cream	22,614
Wash	164	Glycerin and glycerin compounds	138
Lotions	9,612	Lip sticks	5,101
Perfumes	137,034	Lotions	892
Quinine water	860	Pencils and crayons	16,075
Toilet waters	109,780	Perfumes	18,728
Not containing alcohol:		Perfumed cards, etc	335
Bath preparations—		Perfumed stars	147
Crystals	859	Pomade	11,240
Powders	17,364	Orange	509
Salts	5,547	Powder—	
Carbolic foot powder	197	Not specified	44,226
Toilet washing powder	16,831	Face	389,901
Dental preparations—		Leaves	5,025
Carbolic tooth powder	1,575	Rice	146,841
Dental water	257	Sachet	85,573
Tooth paste	9,940	Talcum	90,994
Tooth powder	5,790	Rouge	59,480
Hair preparations—		Shaving cream	973
Brilliantine	1,763	Skin energetic superfine oilve oil	106
Dye	3,734	Smelling salts	1,335
Oil	17,381	Toilet articles	422
Wash	324	Other preparations	1,337
Mascaro	1,905		
Moustache wax	379		
Quinine julep	172		

ALCOHOL REGULATIONS.

The internal-revenue tax on alcohol (distilled spirits) such as is used in the manufacture of perfumes is as follows:

SEC. 600. (Act of February 24, 1919 (40 Stat., 1057).) (a) That there shall be levied and collected on all distilled spirits now in bond or that have been or that may be hereafter produced in or imported into the United States, except such distilled spirits as are subject to the tax provided in section 604, in lieu of the internal-revenue taxes now imposed thereon by law, a tax of $2.20 (or, if withdrawn for beverage purposes or for use in the manufacture or production of any article used or intended for use as a beverage, a tax of $6.40) on each proof gallon, or wine gallon when below proof, and a proportionate tax at a like rate on all fractional parts of such proof or wine gallon, to be paid by the distiller or importer when withdrawn, and collected under the provisions of existing law.

COMPENSATORY DUTY ON ALCOHOLIC PERFUMES.

The revenue act of 1918 also contains the following provision for a compensatory duty on imported perfumery:

SEC. 600. (c) In lieu of the internal-revenue tax now imposed thereon by law there shall be levied and collected upon all perfumes hereafter imported into the United States containing distilled spirits, a tax of $1.10 per wine gallon, and a proportionate tax at a like rate on all fractional parts of such wine gallon. Such tax shall be collected by the collector of customs and deposited as internal-revenue collections, under such rules and regulations as the Commissioner, with the approval of the Secretary, may prescribe.

EXCISE TAX ON SALES.

The excise tax on sales of perfumes, cosmetics, toilet waters, etc., provided by the revenue act of 1918 is as follows:

SEC. 907. (a) That on and after May 1, 1919, there shall be levied, assessed, collected, and paid (in lieu of the taxes imposed by subdivisions (g) and (h) of section

600 of the Revenue Act of 1917) a tax of 1 cent for each 25 cents or fraction thereof of the amount paid for any of the following articles when sold by or for a dealer or his estate on or after such date for consumption or use:

(1) Perfumes, essences, extracts, toilet waters, cosmetics, petroleum jellies, hair oils, pomades, hair dressings, hair restoratives, hair dyes, tooth and mouth washes, dentifrices, tooth pastes, aromatic cachous, toilet powders (other than soap powders), or any similar substance, article, or preparation by whatsoever name known or distinguished, any of the above which are used or applied or intended to be used or applied for toilet purposes;

DRAWBACK ON ALCOHOL TAX.

A drawback is paid on domestic alcohol used in the manufacture of perfumes to be exported according to the following provision in the tariff:

SEC. IV. (Par. O, Act of October 3, 1913 (38 Stat., 192). Extract.) That on the exportation of flavoring extracts, medicinal or toilet preparations (including perfumery) hereafter manufactured or produced in the United States in part from domestic alcohol on which an internal-revenue tax has been paid, there shall be allowed a drawback equal in amount to the tax found to have been paid on the alcohol so used: *Provided*, That no other than domestic tax-paid alcohol shall have been used in the manufacture or production of such preparations. Such drawback shall be determined and paid under such rules and regulations, and upon the filing of such notices, bonds, bills of lading, and other evidence of payment of tax and exportation, as the Secretary of the Treasury shall prescribe.

35284—21—A-14★

AMBERGRIS.

General Information.

PROVISION IN ACT OF 1913.

"49. Ambergris, * * * 20 per centum ad valorem."

DESCRIPTION AND USES.

Ambergris is a decomposition product of the sperm whale, *Physeter macrocephalus* L., and is found in its intestines or floating on the sea. One whale has been known to yield as much as 750 pounds of ambergris, but this is many times the quantity usually recovered. The National Standard Dispensatory (see page 159) describes this material as follows: "It comes in irregular pieces, varying considerably in size, is opaque, of a gray or gray-brown color, with lighter and darker colored streaks and spots, lighter than water, friable in the cold, but softening when held in the hand. It is of waxy appearance, * * * has a peculiar fragrance, [and] is nearly tasteless * * *." The two principal varieties of ambergris on the market are the black and the gray. The former is worth from $10 to $15 per ounce, while the latter is considerably more expensive, usually selling for more than $25 per ounce.

Ambergris is used almost exclusively in perfumery, where it is regarded as a valuable fixative. It is seldom if ever used in modern medicine, but was formerly prescribed in fevers and nervous diseases, in which its action was believed to be analagous to that of musk.

Because of its comparatively high price ambergris is particularly liable to sophistication. Various synthetic materials of similar properties have become available within recent years, and the use of the natural product has declined considerably.

PRODUCTION AND TRADE.

Ambergris is found floating on the sea off the coasts of China, Japan, Sumatra, Madagascar, and Brazil. In fact, this material is occasionally found throughout the entire Southern Hemisphere. The supply of ambergris used in England is said to come almost entirely from the Bahama Islands. Ambergris is found usually in small fragments and in lumps of various shapes and sizes, ranging in weight from one-half ounce to 100 or more pounds.

IMPORTS.

Supplies of ambergris have always been irregular and uncertain, and for this reason imports have shown marked variation in both quantity and value. The maximum prewar import was received in 1911 and amounted to 171 pounds, valued at $22,518. During 1914 only 2 pounds were received, but the material was valued at $347.50

per pound. In 1917, 10 pounds and in 1918, 14 pounds were reported. The import for the fiscal year 1919 was reported to be 9 pounds, valued at $1,097. The imports during the fiscal year 1920 amounted to 3 pounds valued at $180 per pound.

In 1910 and again in 1919 a small quantity of material was shown in the import statistics under the caption "ambergris oil, crude and rectified." In 1910, 44 pounds of this material had a reported value of $22 and the 2 pounds imported in 1919 were valued at $212. Ambergris oil is not known to the trade or to science as such, and information as to the identity of this material is not available at this time.

PRICES.

From January, 1912, until January, 1914, black ambergris was quoted at $15 to $20 per ounce and the gray variety at $25 to $27.50. A slight decrease in April, 1914, brought the price of black ambergris to $12 to $15, and in October, 1916, this was changed to $10 to $15, which price was maintained until the end of 1919. During the first three quarters of 1920 black ambergris has been quoted at $8 to $12. Since April, 1914, the gray variety has ranged in price between $22 to $30 per ounce.

TARIFF HISTORY.

Ambergris was mentioned specifically on the free list of the act of 1883, and a similar provision occurs in the free lists of the acts of 1890, 1894, 1897 and 1909. Ambergris became dutiable under the act of 1913 at 20 per cent ad valorem.

TARIFF CONSIDERATIONS.

Ambergris presents no tariff problem of importance. The imports, which are small and variable, are not competitive with material available from domestic sources. As a source of revenue the article is also unimportant; the maximum revenue was obtained in 1918 and amounted to but $728. From the standpoint of tariff classification, however, attention should be called to the provision in paragraph 46 of the act of 1913 for ambergris oil. There is no material known to the trade by this name and from a consideration of the import statistics it is obvious that this provision might well be omitted in future tariff revisions.

Ambergris [1]*—Imports for consumption—Revenue.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	12	$2,652		$221.00	
1909	do	2	300		150.00	
1910	do	21	4,001		190.52	
1911	do	171	22,518		131.68	
1912	do	17	4,624		272.00	
1913	do	38	10,964		288.53	
1914	do	2	695		347.50	
1915	20 per cent		87	$17		20.00
1917	do	10	2,771	554	277.10	20.00
1918	do	14	3,643	728	260.21	20.00
1919	do	9	1,097	219	121.89	20.00
1920	do	3	540	108	180.00	20.00

[1] Not containing alcohol under the act of 1913.

Ambergris oil, crude and rectified—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	Free	44	$32		$0.728	
1919	20 per cent	2	212	$42	106.00	20.00

Ambergris—Prices, wholesale, New York, spot, in dollars per ounce.

[From Oil, Paint, and Drug Reporter.]

BLACK AMBERGRIS.

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1910
January	$15–$20	$15–$20	$15–$20	$12–$15	$12–$15	$10–$15	$10–$15	$10–$15	$8–$12
April	15– 20	15– 20	12– 15	12– 15	12– 15	10– 15	10– 15	10– 15	8– 12
July	15– 20	15– 20	12– 15	12– 15	12– 15	10– 15	10– 15	10– 15	8– 12
October	15– 20	15– 20	12– 15	12– 15	10– 15	10– 15	10– 15	10– 15	8– 12

GRAY AMBERGRIS.

Month.	1912	1913	1914	1915	1916
January	$25.00–$27.50	$25.00–$27.50	$25.00–$27.50	$22.50–$27.50	$22.50–$27.50
April	25.00– 27.50	25.00– 27.50	25.00– 27.50	22.50– 27.50	22.50– 27.50
July	25.00– 27.50	25.00– 27.50	22.50– 27.50	22.50– 27.50	22.50– 27.50
October	25.00– 27.50	25.00– 27.50	22.50– 27.50	22.50– 27.50	22.00– 28.00

Month.	1917	1918	1919	1920
January	$22.00–$28.00	$24.00–$28.00	$28.00–$30.00	$27.50–$30.00
April	22.00– 28.00	24.00– 28.00	28.00– 30.00	27.50– 30.00
July	22.00– 28.00	24.00– 28.00	28.00– 30.00	27.50– 30.00
October	24.00– 28.00	22.00– 24.00	28.00– 30.00	27.50– 30.00

Ambergris—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	498	Ambergris	Free.
1890	480	.....do	Do.
1894	370	.....do	Do.
1897	471	.....do	Do.
1909	489	.....do	Do.
1913	49	Ambergris, * * * all the foregoing not containing alcohol * * *.	20 per cent.

ENFLEURAGE GREASES AND FLORAL ESSENCES.

(Par. 49, Act of 1913, 20 per cent ad valorem.)

SUMMARY.

Enfleurage greases and floral essences are natural products obtained by extracting the odorous principles or perfumes of flowers by means of a solvent. They are the materials from which practically all alcoholic perfumery is manufactured and are not finished products in the sense that they can be used as such by the ordinary consumer.

"Enfleurage greases" and "floral essences" are not the usual commercial designations for the articles imported under these provisions of the tariff. They have, therefore, especially in the case of enfleurage greases, occasioned considerable litigation. From a scientific and technical point of view enfleurage grease refers only to the purified lard, tallow, or vaseline, which has been saturated with flower odors as a result of the enfleurage process. In this process the flowers are brought into contact with either cold or heated grease, which absorbs the odors of the flowers much in the same way that butter kept in a closed refrigerator absorbs the flavors of fruits or vegetables. When the grease is sufficiently charged with the delicate floral odors, it becomes known on the market as a "pomade." These pomades or enfleurage greases are imported into this country and the odors obtained from them by washing with alcohol.

"Floral essences" are known to the trade as "concrete essences," or "floral concretes," and are obtained by treating flowers, such as the rose, jasmine, and tuberose, with petroleum ether or some other volatile solvent, which extracts the odors and after evaporation leaves a waxy residue containing all of the odoriferous constituents of the flowers. From these concretes the odors may be recovered by washing with alcohol. Since the concretes are free from fatty matter they are even more important than the pomades as a basis for alcoholic perfumery.

"Absolute essences," also logically included in the classification "floral essences," are obtained by washing either the pomades or the concretes with alcohol and evaporating off the solvent.

Enfleurage greases and floral essences are products of southern France. Both the enfleurage and volatile-solvent processes were developed and have been used almost exclusively in that country Accurate statistics of the French industry have not been published, but it has been estimated that before the war France produced annually about $6,000,000 worth of natural perfume raw materials. The United States, Great Britain, and Germany were the largest foreign consumers of these materials. The maximum imports of enfleurage greases into the United States were received in 1911 and amounted to 128,656 pounds, valued at $232,821. The average annual prewar import was in the neighborhood of 90,000 pounds. The value per pound has shown wide variation, ranging from $1.25 in 1914 to $14.69 in 1919. Imports of floral essences have only been

shown as such in official statistics since 1910. In 1912 they reached 11,566 pounds, valued at $205,376: and while the quantity dropped to 9,440 pounds in 1913, the total value increased to $470,684. Statistics since 1914 have not shown the quantity of imports, and for the period 1915–1918 the average value reported was about $266,000. In 1919 imports of floral essences fell to $34,610.

Enfleurage grease was mentioned specifically on the free list of the act of 1894, and imports were entered free until the act of 1913 imposed a duty of 20 per cent ad valorem. Floral essences, mentioned for the first time in the act of 1909, also became dutiable at 20 per cent ad valorem in the act of 1913.

The tariff provisions for these articles present the following problems: (1) The need for a more precise and scientific definition of the terms "enfleurage greases" and "floral essences by whatever method obtained"; (2) the advisability of restricting these provisions to the natural uncompounded products and excluding from them all combinations of floral odors, either with natural products, such as essential oils, or with artificial materials, such as the synthetic aromatic chemicals; and (3) the relation of the rates of duty imposed on (*a*) essential oils and similar perfume raw materials and on (*b*) finished perfumes and cosmetics.

General Information.

PROVISION IN THE TARIFF ACT OF 1913.

"49.— * * * enfleurage greases and floral essences by whatever method obtained; * * * all the foregoing not containing alcohol * * * 20 per centum ad valorem."

DESCRIPTION.

Enfleurage greases and floral essences are natural floral products which form the basis for the manufacture of practically all alcoholic perfumery. In a general way they may be said to represent the vehicle in which the flower odors are transported from their natural habitat to the place where the finished perfume is compounded. They are not therefore completed products ready for use by the ordinary consumer but must be subjected to further manufacture by the skilled perfumer. It should be pointed out that enfleurage greases and floral essences are not usual trade designations, definitely identifying certain particular products, but are descriptive rather of a group of materials obtained from flowers by similar or related processes.

Enfleurage grease in the restricted scientific sense refers only to the grease which has been saturated with the flower odors as a result of the enfleurage process. This process originated and has been used almost exclusively in France. Briefly, it consists of either spreading the fresh blossoms onto a thin layer of a pure cold fat, which absorbs the floral odors, or of immersing the flowers in warm melted fat and allowing them to macerate until the grease is fully charged with the delicate odors. The saturated fat obtained from either the cold or warm method is known technically as a "pomade" (French: pommade) and represents the true enfleurage grease. The

courts, however, have given a more liberal construction to the term, so that it includes not only the flower odors extracted by fat through enfleurage process but also the concentrated products obtained by extraction with volatile solvents, such as alcohol, petroleum ether, or carbon disulphide. The latter products are known to the trade as "concretes" and are somewhat more expensive than the corresponding pomades, because while they contain all of the odoriferous constituents of the flowers they are entirely free from fatty material. Although these concretes appear more logically to fall under the provision for "floral essences, by whatever method obtained," they are nevertheless entered as "enfleurage greases." The former provision appeared for the first time in the act of 1909, and the "concretes" had already been judicially held to come within the older provision for "enfleurage greases."

The term "floral essence" is also used rather loosely to apply to a number of related perfume materials. The word "essence" is used in some countries to designate the volatile or essential oils, but in the United States it has unfortunately been applied chiefly to the alcoholic solutions of the essential oils—which occasionally are more correctly called "spirits." The origin of the word is found in the French language, where it is used to mean the quality or qualities on which an object depends for being what it is. Consequently, in France the essential oils are designated as *essence*, e. g., *essence de rose* and *essence de lavender*.

In England the term is commonly used to designate the alcoholic solutions of the constituents that compose the essential oil. In Germany essence is apparently restricted to those essential oils which are not obtained by distillation, but by expression, such, for example, as the essential oils of the citrus fruits.

As used in the tariff act of 1913, the term is qualified by the phrase "by whatever method obtained" and the provision that it shall not contain alcohol. In practical application it is therefore limited chiefly to the materials known in the trade as "concretes" (see above) and "absolutes." These products are of similar appearance, but are prepared by slightly different methods. While the concretes are obtained by direct extraction of the flowers, the absolutes are prepared by extracting with alcohol either the pomades from the enfleurage process or the concretes from the volatile-solvent process, and wholly or partially evaporating off the solvent.

USES.

Enfleurage greases (or pomades) and floral essences are the natural bases for the manufacture of practically all alcoholic perfumery, although various other materials must necessarily be added in order to render the odors more pronounced or more durable. The alcoholic extracts are usually obtained from the pomades by a thorough mixing in a churn-like extractor. After the alcohol has become saturated with the perfume from the pomade it is strained in order to filter out fatty particles and to get a clear alcoholic extract. This extract is then chilled at a low temperature in order to separate out the small quantities of fatty material held in solution. The pomade on the filter is returned to the extractor and re-treated with alcohol, and the process is repeated three or four times, or until the perfume

has been exhausted from the grease. The residual fatty material, known as "washed pomade," still retains sufficient odor to render it valuable for the preparation of hair pomades or in toilet-soap manufacture.

The concrete essences are washed with alcohol in a somewhat similar manner as the pomades, but since they are free from fatty substances they require but a slight chilling to remove only the natural inert waxes of the flowers. The absolute essences are entirely soluble in alcohol and therefore permit of the greatest ease in the manufacture of the alcoholic extracts.

PROCESSES OF MANUFACTURE.

A. *Enfleurage.*—The enfleurage process is used to recover from certain flowers the delicate odors which would be destroyed or seriously modified in the ordinary steam distillation process. As used in France, the process is generally held to include two modifications, viz, (1) absorption or *enfleurage a froid*, and (2) maceration or infusion (*enfleurage a chaud*).

(1) *Absorption or enfleurage.*—In this process a pure neutral odorless grease such as purified lard, tallow, or vaseline is spread in thin layers onto both sides of a glass plate, which rests on a frame, usually about 20 inches by 24 inches, and known technically as a "chassis aux pomades." The fresh blossoms are thinly sprinkled or laid one by one on the upper surface of this tray. Similar chassis are charged with fat and flowers and are stacked one upon the other. Thus, a number of rectangular chambers are formed, of which the upper and lower surfaces are coated with fat. The volatile odors emanating from the flowers are absorbed by the upper surface, while the lower surface becomes perfumed by contact. After a number of hours, depending upon the species and quantity of flowers used. the blossoms are removed and replaced by fresh ones. In the case of jasmine, the frames are allowed to stand for 24 hours, for jonquills, 48 hours, while tuberoses usually require 3 days. This process is repeated for 25 to 30 days, or until the pomade has attained the desired strength or concentration. On the whole, the enfleurage process is long and tedious and requires a great deal of hand labor. The final removal of the flowers from the saturated grease is particularly slow and tedious and often costly because of loss of the valuable grease. A new apparatus (discussed in the American Perfumer for April, 1919, p. 41) removes the bulk of the flowers by passing them through a brushing device, and the smaller particles, roots, and fragments are then plucked off by a small suction tube in such a manner that the pomade is not touched by hand. This apparatus is not as yet widely used, but is reported to have been adopted by one of the more important French factories.

The original enfleurage process is still in operation on a considerable scale in France, although certain modifications have been attempted in order to shorten the process or reduce the amount of labor involved. In the first, a large number of glass plates are placed horizontally in inclosed chamber which is connected by means of a tube with a smaller chamber filled with flowers. The purified grease is placed on the plates and by means of a small fan a current of warm air is drawn through the flowers and over the fat. The grease thus absorbs the

odors without actually coming into contact with the flowers. The absorption is effected rapidly and the flowers can be replaced with greater ease than in the original process.

The second modification is based on similar principles, except that the flowers are placed on trays over which is drawn a current of moist air.

Still another modification, although not of a mechanical nature, is based on the substitution of olive oil for the pure lard used in the "pomade process." A long piece of cotton cloth is saturated with olive oil and laid upon a sieve or wire netting. The flowers are placed thereon and left until fresh ones are substituted. After the oil has become charged with the perfume, the cotton cloths are removed from the frames and the saturated oil is obtained by expression. These products are known in the trade as *huiles antiques*. The olive-oil process, however, is not largely used for isolating the perfumes, but is carried on to some extent for the *huiles antiques* to be used in hair oils.

Pomades appear on the markets in several grades of varying strength. These are sometimes designated by the weight of flowers used in their preparation, but more often by arbitrary numbers, e. g., No. 6, No. 18, and No. 30, or No. 12, No. 24, and No. 36, based on their comparative strength or concentration.

(2) *Maceration or infusion.*—This process is also used for flowers in which the volatile oils are decomposed or altered by the heat and water used in the distillation process. The method is similar to the cold enfleurage process in that it depends upon the affinity of odoriferous substances for fats and greases, which, when impregnated with the odors, are known as pomades. The process differs from cold enfleurage in that the animal or vegetable fats are used at a temperature of about 65° C. and the flowers are put in actual contact with the fat; i. e., they are thoroughly macerated with it. The process is quite rapid and the flowers are pressed from the grease to yield the pomades. When olive oil is substituted for the lard or mineral grease, *huiles antiques* similar to those previously described are obtained.

Maceration is used principally for obtaining the perfume from roses, violets, orange flowers, jonquils, and cassie flowers.

B. *Volatile-solvent process.*—The volatile-solvent process, although somewhat analogous to the warm enfleurage or maceration process, can not accurately be considered as a modification of the enfleurage method. It represents rather a new development, which, because of its mechanical advantages, is largely replacing the enfleurage method for extracting many of the flower odors. This method, which has been described in a general way in the tariff information survey for essential oils (par. 46), is considered in the present connection, since it is the method used in obtaining the bulk of the material imported into this country under the provisions "enfleurage greases and floral essences by whatever method obtained."

The principal volatile solvents which have been used for the extraction of flower odors are alcohol, petroleum ether (benzine), carbon bisulphide, and chloroform. Of these petroleum ether is by far the most largely used. It is usually a very carefully rectified grade which does not possess a disagreeable odor and evaporates completely at about 50° C. The apparatus used for the extraction differs in the

various establishments, but consists essentially of the following parts: (1) An extractor or diffuser in which the flowers, usually spread out on trays, are treated with the cold volatile solvent; (2) a decanter in which the flowers are separated from the solvent; (3) a still in which the solvent is distilled off under reduced pressure and returned to extractor to complete the cycle of operation. Although a simple distillation process, it must necessarily be very carefully controlled. (4) A number of reservoirs for storing the pure solvent or that which has been saturated with the perfume from the flowers.

In modern plants a large number of diffusers are connected in the form of batteries and the process, which is a continuous one, is conducted on a large scale. The fresh blossoms are usually employed in this process, although it can be applied profitably to flowers previously treated by the cold enfleurage method.

The concrete essences are usually of a wax-like character, because of the fact that the solvent in extracting the odoriferous constituents dissolves out a part of the natural flower waxes and other substances, which from the perfumer's viewpoint, are regarded as impurities. The concretes, however, are not necessarily solids or semisolids, since a few liquid concretes are occasionally met with. The concrete essences are extremely valuable—according to Durvelle—a pound is often equivalent to 100 pounds of pomade.

The absolute essences, which are sometimes confused with the concretes, are prepared from the pomades or the concretes by washing with alcohol and evaporating off the solvent. In this way a considerable proportion of the waxes and inert constituents are removed, and for this reason most of the absolutes are in a liquid form.

PRODUCTION AND TRADE.

The French industry.—Enfleurage greases and floral essences or concretes are produced almost exclusively in southern France Although flower cultivation is carried on to a limited extent in Germany and Algeria, the bulk of the world's supply of these natural perfume bases originates in Grasse, France, in Alpes-Maritimes department. A considerable number [1] of establishments are engaged in the manufacture of these materials, the largest of which have branches in Paris, New York, London, and other centers for the manufacture of the finished perfumes.

The French export statistics, unfortunately, do not show detailed figures for the exports of enfleurage greases and floral concretes. The American consular reports from the Nice district appear to be the best available source of information in regard to the industry. In a report dated November 14, 1917, Consul W. D. Hunter gives the following statement of conditions in 1916:

> The manufacture of the primary articles of perfumery is the most important industry in this consular district. Before the outbreak of the war about 2,400 persons were engaged in the production of concretes and floral essences, enfleuraged greases, and floral waters; the output in 1913 was estimated at $6,000,000.

[1] According to the report of the Nice Chamber of Commerce for 1914, there are 70 works in Grasse, Cannes, Le Cannet, Golfe Juan, Vallauris, Nice, and Antibes (all in the Department of Alpes-Maritimes) for the production of perfumery. Over one-half of the works are located in Grasse. (Schimmel & Co., Semi-annual Report, Oct., 1916, p. 86.)

In 1916 this industry was handicapped by poor crops of violets and roses, and although the yield of orange blossoms, tuberoses, and jasimine was abundant, as well as that of lavender, thyme, aspic, and other aromatic plants, the necessary labor to gather these flowers was not obtainable and large quantities remained unpicked. The scarcity of alcohol, which is extensively used in the perfume industry for the extracting of the odorous matter from the enfleuraged greases and the fiscal difficulties connected with its importation were other hindrances. The scarcity and high price of coal was another difficulty with which this industry had to cope. Nevertheless, the perfume industry in this district had a satisfactory year, owing largely to the fact that the large plants had considerable quantities of the articles manufactured by them in stock and that exports, especially to South America and Spain, were greatly increased, as before the war these countries bought such goods from Germany.

The output of the various perfumery plants in 1916 was small, but larger than in any year since the outbreak of the war. The demand for floral essences of lavender and aspic, especially from Great Britain, was large and the prices paid were good. Neroli, the floral essence of the orange blossom, was distilled in satisfactory quantities. To sum up the situation of the floral industry at the end of 1916, the production of floral concretes was greater because these are produced practically without fuel and alcohol; the output of enfleuraged greases diminished, as fine fats, imported from Italy before the war, were hardly obtainable, and the use of alcohol is necessary for the extraction of the odorous matters from these greases; the distillation of essences of patchouli, sandalwood, and rosewood, which are manufactured from raw material imported from India and other tropical regions, also diminished owing to the difficulties of transportation and high freight and insurance costs. The essence of iris was not distilled in 1916, as the quantity of coal needed made the cost of its production too high. The difficulty of importation of geranium d'Afrique, or Bourbon, confined its distillation principally to home-grown plants; the reported stock of essence produced was greatly reduced.

The same official on December 5, 1918, gave the following additional information, as a summary of conditions during 1917:

Floral essences, floral concretes, and other raw materials of perfumery exported to the United States alone amounted to $1,290,650 in 1912 and to $1,578,229 in 1913—the last two years before the war—and the 1917 exports were valued at $1,024,482. The exports were exceptionally high in 1913, the average for the last five years prior to the war being only about $1.137,000 annually. The exports to America, therefore, for 1917 nearly reached the average of the prewar exports. Since the year 1913 two of the largest perfume factories of this district have combined and moved their commercial office to Paris, in consequence of which the exports to the United States of this firm do not figure in the exports of perfumery from the Nice district after 1913.

Inquiries made at nearly all the larger perfume factories at Grasse showed that, although a scarcity of labor was less keenly felt in that industry than in others (for the proportion of men laborers is at all times comparatively small), the work was carried on under the most trying circumstances. Alcohol and lard were high and difficult to procure; the prices of flowers increased (for instance, orange blossoms selling at 1.50 francs (29 cents) and roses selling at 2.50 francs (48 cents) a kilo in 1916 brought 2 and 3.50 francs (39 and 68 cents), respectively, in 1917); and the difficulties of transportation, of procuring export licenses, and of securing experienced clerical assistance were keenly felt.

IMPORTS.

The maximum imports of enfleurage grease into the United States were received in 1911 and amounted to 128,656 pounds, valued at $232,821. The average annual prewar import was in the neighborhood of 90,000 pounds. The duty value per pound, however, is reported to have ranged from $1.25 in 1914 to $4.02 in 1909. Since 1914 the imports of enfleurage grease have fallen off considerably, and in 1916 amounted to only 5,245 pounds, valued at $8,524. The average quantity of enfleurage grease received during the years 1915–19 was 19,443 pounds. The value per pound increased from $1.27 in 1917 to $7.10 in 1918, and the latter figure more than doubled in 1919, when a value of $14.69 was reported. Imports of enfleurage grease have come entirely from France.

Imports of floral essences were first included as such in the statistics for 1910. In 1910 they amounted to 3,210 pounds, valued at $31,845. In 1911 the quantity fell to 2,143 pounds, while the value increased to $65,679—or from $9.92 per pound in 1910 to $30.65 in 1911. In 1912 the quantity reached the maximum of 11,566 pounds, and in 1913 the value reached the maximum of $470,684, or $49.86 per pound.

Since 1914 the quantity of the imports has not been shown. The value has ranged from $406,136 in 1917 to $34,610 in 1919.

The maximum revenue obtained from enfleurage grease was received in 1919 and amounted to $39,269. Floral essences yielded a revenue of $81,227 in 1917, and in both 1916 and 1918 exceeded $60,000.

PRICES.

Wholesale prices for enfleurage greases and floral essences are not quoted in the trade journals, chiefly because the products of the different manufacturers vary considerably in quality and price and there are no standard specifications for these articles. In general, however, these articles range in price from $50 to $100 per pound, although during 1920 prices as high as $500 to $750 have been quoted for many of the flower essences. The floral concretes, as previously noted, are more valuable than the pomades, since they represent a much greater equivalent in flowers.

The duty value of the enfleurage grease imported for consumption in the United States was $1.25 per pound in 1914, as compared with $46.37 per pound for floral essences. In 1919 imports of enfleurage grease had a declared value of $14.69, but comparable data are not available for the imports of floral essences.

TARIFF HISTORY.

Enfleurage grease was mentioned specifically on the free list of the tariff act of 1894, and imports were entered free of duty until the act of 1913 imposed a duty of 20 per cent ad valorem. Floral essences were not enumerated as such in the tariff until 1909, when the free list of the act of that year contained a provision for "liquid and solid primal flower essences not compounded." In the act of 1913 floral essences became dutiable at 20 per cent ad valorem and the provision was changed to read: "floral essences by whatever method obtained * * *; all the foregoing not containing alcohol."

TARIFF CONSIDERATIONS.

The provision for enfleurage grease has been the subject of much litigation and in the "Notes on Tariff Revision" (p. 757), prepared for the use of the Ways and Means Committee in 1909, it was strongly urged that if the provision be continued it should embody a more precise definition for the article. The language proposed for that provision was as follows:

> Enfleurage grease, which term shall include only an odor of a flower extracted by means of a solvent, but not combinations of such odors nor of a floral odor with essential oil, nor of essential oils.

Instead of accepting this proposal, however, Congress expanded the provision so that it might include all natural flower odors. The provision in the act of 1909 reads: "enfleurage grease, liquid and solid primal flower essences not compounded."

In the act of 1913 these articles were placed on the dutiable list and given the same rate of duty as provided for the essential oils. This appears to be a logical procedure in carrying out the evident intention of Congress to impose duties on the raw materials for perfumery and cosmetics. The enfleurage greases and floral essences are of somewhat greater value than most of the essential oils, but they have similar use in perfume manufacture.

The qualifying words "primal" and "not compounded" included in the act of 1909 were for the purpose of excluding mixtures and compounded preparations, such as the "artificial essential oils" and materials consisting of a natural floral base to which various aromatic chemicals and other substances have been added (see T. D. 32504). Preparations of this type were not specifically provided for in the act of 1909, but under the act of 1913 would presumably be included in the provision for "all natural or synthetic odoriferous or aromatic substances, preparations, and mixtures used in the manufacture of, but not marketable as, perfumes or cosmetics." They are generally more highly manufactured products than are the pomades and concretes, and are often made up of a number of ingredients carefully compounded to simulate a flower odor which can not be extracted from the natural flower. Finished perfumes may be made from many of these mixtures merely by the addition of alcohol.

In any future tariff revision, consideration should be given to the advisability of more scientific treatment for both enfleurage greases and floral essences. The following tentative suggestion is offered as a possible improvement of the present provision:

> Materials used in the manufacture of, but not marketable as, perfumes or cosmetics, and not containing alcohol:
> (*a*) Animal products: Ambergris; musk, grained or in pods; and civet.
> (*b*) Floral products, primal and not compounded: Flower pomades or enfleurage greases, floral essences and concretes, by whatever method obtained.

Enfleurage grease [1]*—Imports for consumption—Revenue.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	95,020	$266,692		$2.81	
1909	do	91,562	368,469		4.02	
1910	do	64,909	143,773		2.21	
1911	do	128,656	232,821		1.81	
1912	do	72,195	110,824		1.54	
1913	do	92,446	124,195		1.34	
1914	do	21,853	27,866		1.28	
	20 per cent	18,785	23,551	$4,710	1.25	20
1915	do	28,407	31,578	6,315	1.11	20
1916	do	5,245	8,524	1,704	1.62	20
1917	do	26,588	33,760	6,752	1.27	20
1918	do	23,620	167,861	33,572	7.10	20
1919	do	13,357	196,345	39,269	14.69	20

[1] Not containing alcohol under the act of 1913.

Floral essences, liquid and solid, primal not compounded—Imports for consumption—Revenue.

[Act of 1909.]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	Free	3,210	$31,845		$9.92	
1911	do	2,143	65,679		30.65	
1912	do	11,566	205,376		17.76	
1913	do	9,440	470,684		49.86	
1914	do	6,229	288,824		46.37	

Floral essences [1]*—Imports for consumption—Revenue.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1914	20 per cent		$87,086	$17,417		20
1915	do		145,973	29,194		20
1916	do		265,956	53,191		20
1917	do		406,136	81,227		20
1918	do		250,531	50,106		20
1919	do		34,610	6,922		20

[1] Containing no alcohol under the act of 1913.

Enfleurage grease and floral essences—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1894	568	* * * Enfleurage grease * * *.....	Free.
1897	626	* * * Enfleurage grease * * *.....	Do.
1909	639	* * * Enfleurage grease, liquid and solid primal flower essences not compounded * * *.	Do.
1913	49	* * * Enfleurage greases and floral essences by whatever method obtained; * * * all the foregoing not containing alcohol * * *.	20 per cent.

Court and Treasury Decisions.

There is conflict in the decisions upon enfleurage grease. In a case under the act of 1894 an importation described as "odorous pastes containing the highly concentrated perfumes of various flowers, suitable for use only in the manufacture of pomades and perfumery" was declared by the Board of General Appraisers to be most appropriately designated as "enfleurage grease." The Board of General Appraisers relied upon the definition of "enfleurage" given in the United States Dispensatory, edition of 1894, folio 912, as being a term "applied by the French to the impregnation of fixed oils and fatty matters with the odors of certain sweet-scented plants." The proper classification was held to be as "enfleurage oil" under paragraph 60 of that act. (In re Dodge, G. A. 3603, T. D. 17412, of 1896.) The Treasury Department acquiesced in this decision but instructed customs officers to classify future importations of this

merchandise as unenumerated manufactured articles. (T. D. 17382 of 1896.)

The Circuit Court for the Southern District of New York held that "odorous pastes" or "concrete essences of perfumes" classified by the collector as "essential oils" under the act of 1894 were exempt from duty as enfleurage grease. The evidence in that case tended to show that the enfleurage process consisted of extracting the odorous principle or perfume of flowers not only by the use of animal fats but also by the employment of vegetable oils, vaseline, and petroleum, a variety of the last named being the solvent in that case; and that there was no commercial meaning in the wholesale trade in the United States associated with the term "enfleurage grease," but that such term, according to its French meaning and as understood by manufacturers and those dealing in such products in the United States, covered all the forms of fatty or greasy substances employed in extracting and transmitting the perfume of flowers for use in the manufacture of perfumery. (United States *v.* Dodge, 94 Fed., 481, of 1899; followed in G. A. 4499, T. D. 21424, as to similar odorous pastes.) The Treasury Department acquiesced in this decision. (T. D. 21306 of 1899.)

An importation invoiced as "enfleuraged pomade, concentrated, not suitable for toilet use," classified by the collector as an essential oil under paragraph 3 of the act of 1897 was held to be exempt from duty as enfleurage grease under paragraph 626 of that act. (G. A. 5200, T. D. 23965 of 1902.)

Concrete essences of flowers, viz, acacia, violet, reseda, lily of the valley, cassia, rose, tuberose, jasmine, and orange, were likewise held exempt from duty. (Abstract 409, T. D. 25023 of 1903.)

An importation invoiced as "Concrete Iris de Florence extra" was found not to be an enfleurage grease but an essential oil of orris and dutiable accordingly under paragraph 3 of the act of 1897. The term "enfleurage grease" was declared to apply to the products of the volatile solvent process for the extraction of odor-bearing bodies other than flowers. (G. A. 5972, T. D. 26181 of 1905.)

Merchandise invoiced as "pomade lily of the valley" and returned by the appraiser as "a combination of essential oils (muguet)," was likewise classified under paragraph 3 of the act of 1897 (G. A. 6024, T. D. 26310 of 1905), but the board's decision was reversed, without opinion, by the Circuit Court for the Southern District of New York on the authority of the Dodge case, supra. (Lueders *v.* United States, 143 Fed., 918; T. D. 26882, of 1905.)

The decision in the Lueders Case was followed by the board as to merchandise described as "Florescence Valley Lily" and "Valley Lily Enfleurage Pomade." (G. A. 6219, T. D. 26886; T. D. 26930, of 1905.) The record showed that the essential oils were introduced after the completion of what is known as the enfleurage process (i. e., the abstraction of the odors from the flowers), but the board's decision was reversed by the Circuit Court for the Southern District of New York without opinion, as to the "Florescence Valley Lily." (United States *v.* Ungerer, T. D. 28210 of 1907.)

In another Leuders case "pomade lily of the valley" was held exempt from duty as enfleurage grease. (G. A. 6483, T. D. 27727 of 1906.)

An importation invoiced as "pomade not soluble muguet," and reported by the appraiser in substance to be the result of a combination of floral odors containing a waxy substance carrying the odor of "muguet lily of the valley" was held properly classified by the collector as an essential oil. (G. A. 6798, T. D. 29237.) The board declared that the product was similar to the "florescence valley lily" only in that it was a combination of floral odors and of about equal value and that it differed in containing waxy substances. The board further said:

> The term "enfleurage grease" has been liberally construed by the courts, so that now unquestionably floral odors, whether extracted through the medium of fat or the volatile solvent process, are recognized as being such grease and entitled to free entry; but there is apparent conflict as to whether combinations of odors thus extracted should be so classified.
>
> We are decidedly of the opinion that where such odors have been separately extracted and compounded before importation, particularly where other substances are added which tend to give the combined article a new and different character, such a combination is no longer enfleurage grease within the meaning of the term as used in paragraph 626, and is not therefore entitled to free entry.

In the last case under the act of 1897, the merchandise was invoiced as "Concrete Muguet de Mai." The board based the affirmance of the collector's classification under paragraph 3 as an essential oil upon the ground that the merchandise was in all essential particulars the same as the "florescence valley lily." The Court of Customs Appeals, however, reached the conclusion that the article was different and was properly classable as "enfleurage grease." An "enfleurage grease," the court declared, does not necessarily lose its character, although it is a mixture of several greases, bearing odors of flowers, provided, of course, the grease remains a crude product which can only be used when imported by washing, or treatment which will get out of it the odor principles of flowers. (Burr *v.* United States, 1 Ct. Cust. Appls., 126, 131.)

In a case under the act of 1909 the Board of General Appraisers held that the insertion of the words "liquid and solid primal flower essences not compounded" after the words "enfleurage grease" in paragraph 639 was for the express purpose of excluding from that that paragraph any combination of floral odors whether natural, synthetic, solid or liquid. This restricted paragraph 639 to enfleurage grease derived from a single flower and containing only the odor of that particular flower. The importation was held properly classified as an essential oil under paragraph 3. (G. A. 7361, T. D. 32504 of 1912.)

FLAVORING EXTRACTS.

(Paragraphs 16 and 49, Act of 1913.)

SUMMARY.

Flavoring extracts have been defined by the United States Department of Agriculture as alcoholic solutions of the flavoring and odorous principles of plants. They are obtained by extracting the fruits, seeds, leaves, and roots with alcohol or by dissolving essential oils in strong alcohol. A second class of extracts consists of solutions of different synthetic aromatic chemicals which possess odors and flavors similar to the natural products. The Department of Agriculture requires that these extracts be labeled as "imitations" or "substitutes." These synthetic chemicals may be coal-tar products, such as coumarin, the flavoring principle of tonka beans, or methyl salicylate, the artificial oil of bitter almonds. Other products, especially the so-called "fruit ethers and essences," are made from fusel oil and other higher alcohols. The United States is one of the largest producers, if not the largest, of flavoring extracts. The Census of Manufactures in 1914 reported an output valued at $11,380,423. In addition, there were considerable quantities of flavoring materials made for use in liquors and soft drinks. The output of vanillin, the basis for imitation vanilla extracts, amounted in 1914 to 120,619 pounds, valued at $525,219. Domestic production of coal-tar flavors during 1917–1919 has averaged about 600,000 pounds, worth in the neighborhood of $2,000,000.

Domestic exports of flavoring extracts and fruit juices have increased in value from about $100,000 in 1914, to $1,350,000 in 1919. Our principal customers for these materials have been England, Canada, and the Latin-American countries. The imports of flavoring extracts have averaged less than 1 per cent of the exports. Nonalcoholic flavoring extracts have been received in the largest quantity, and in 1919 the imports amounted to 3,428 pounds, valued at $11,290. The value of the imports of all of the alcoholic flavoring extracts totaled only about $4,000 for the six-year period 1914–1919.

Flavoring extracts were mentioned specifically in the tariff for the first time in the act of 1913. Compound (specific and ad valorem) duties were provided for alcoholic extracts, depending upon their alcoholic content. For those containing 20 per cent or less of alcohol the rate is 10 cents plus 20 per cent ad valorem; for those containing more than 20 per cent and not more than 50 per cent, 20 cents per pound plus 20 per cent ad valorem, and for those containing more than 50 per cent of alcohol, 40 cents per pound plus 20 per cent ad valorem. Nonalcoholic flavoring extracts are dutiable at 20 per cent ad valorem under paragraph 49 of the act of 1913. The act of 1916 provides a duty of 30 per cent ad valorem on flavors of coal-tar origin.

In connection with the tariff classification for flavoring extracts, attention is called to the apparent conflict between paragraph 49

and the Department of Agriculture's regulation that in interstate commerce these articles must contain alcohol in order to be legitimately entitled to the term "flavoring extracts." It is also pointed out that the internal-revenue tax on alcohol used in the manufacture of flavoring extracts was doubled by the war revenue act of 1918, and that there was no corresponding tax imposed on imported flavoring extracts, as was provided in the case of imported perfumery and cosmetics.

General Information.

Act of 1913.—Paragraph 16, "* * * flavoring and other extracts and fruit essences, * * * if containing 20 per centum of alcohol or less, 10 cents per pound and 20 per centum ad valorem; containing more than 20 per centum and not more than 50 per centum of alcohol, 20 cents per pound and 20 per centum ad valorem; containing more than 50 per centum of alcohol, 40 cents per pound and 20 per centum ad valorem."

Paragraph 49, "* * * flavoring extracts, * * * not containing alcohol and not specially provided for in this section, 20 per centum ad valorem."

Act of 1916.—Group III, section 500, "All * * * flavors * * * not otherwise specially provided for in this title, when obtained, derived, or manufactured in whole or in part from any of the materials provided for in Groups I and II * * * 30 per centum ad valorem."

Description and Uses.

The term "flavoring extract" is defined by the Department of Agriculture, in connection with its administration of the pure food and drugs act, in Circular No. 19, dated June 26, 1906, and entitled "Standards of Purity for Food Products," as follows:

> A flavoring extract is a solution in ethyl alcohol of proper strength of the sapid and odorous principles derived from an aromatic plant, or parts of a plant, with or without its coloring matter, and conform in name to the plant used in its preparation. (The flavoring extracts herein described are intended solely for food purposes, and are not to be confounded with similar preparations described in the Pharmacopœia for medicinal purposes.)

This regulation mentions alcohol as a constituent of flavoring extracts. Paragraph 49 of the act of 1913, on the other hand, provides for flavoring extracts not containing alcohol.

Flavoring extracts are typically American food products, although they are used to a considerable extent in the other Anglo-Saxon countries. The two most important flavoring extracts are vanilla and lemon, and it has been estimated by the Department of Agriculture [1] that they represent more than 95 per cent of the domestic consumption. Vanilla extract alone probably constitutes between 80 and 90 per cent of the total.

The other extracts used for flavoring food include the following: Almond, anise, celery seed, cassia, chocolate, cinnamon, clove, ginger, lemon, nutmeg, orange, peppermint, rose, savory, spearmint, star anise, sweet basil, sweet marjoram, thyme, tonka, and wintergreen.

Kessler, an American authority on the manufacture of flavoring

[1] "The Manufacture of Flavoring Extracts," by E. M. Chace, Department of Agriculture Year Book 1908, pp. 333-342.

extracts, has proposed the following classification based on method of manufacture:

(1) Flavoring extracts obtained by maceration and percolation of the beans, seeds, roots, leaves, and fruit of plants. Important examples of this class are extracts obtained from vanilla beans, tonka beans, ginger, and celery seed.

(2) Flavoring extracts obtained by dissolving essential oils in alcohol. Examples of this class are the extracts of essential oils in alcohol such as the extracts of lemon, orange, cinnamon, cassia, almond, peppermint, and wintergreen.

(3) Flavoring extracts obtained by the solution in alcohol of (*a*) synthetic flavors of coal-tar origin, such as vanillin and coumarin; and (*b*) aromatic chemicals known as "fruit ethers and esters." Examples in class (*a*) include imitation vanilla extracts made from vanillin, imitation tonka extracts containing synthetic coumarin, imitaiton wintergreen extracts from methyl salicylate, and imitation almond extracts from benzaldehyde. Examples under (*b*) include the fruit essences of pineapple, quince, pear, and apple.

The Department of Agriculture requires that "imitation flavors must be labeled in unambiguous language, as 'imitation' or 'substitute,'" and this ruling has tended to restrict the sale and use of these products.

In addition to the well-known uses of flavoring extracts by the housewife, these products are extensively employed in the manufacture of ice creams and ices, confectionery of all kinds, fruit sirups, and beverages, patent medicines, and medicinal compounds, perfumery, and cosmetics, jellies and gelatin, and in many other manufactured food products.

The industry was formerly rather closely allied with the manufacture of various liquors and cordials, such as creme de menth, vermuth, and large quantities of flavoring extracts are still used abroad for this purpose.

METHODS OF PRODUCTION.

Vanilla extract.—There are a number of different kinds and qualities of vanilla beans, and these are discussed in considerably more detail in the Tariff Information Survey for paragraph 70 of the act of 1913. The vanilla bean contains on an average from about 1.7 to 2.75 per cent of vanillin. In addition to this important constituent there are smaller quantities of resins and gums, which also contribute to the fragrance and value of the vanilla extract. Vanillin is prepared synthetically from eugenol, a product obtained from oil of cloves. True vanilla extracts are obtained from the beans by a maceration process. This consists of placing finely divided beans, together with the required amount of strong alcohol, into an air-tight container, which is agitated by mechanical means. After the beans have remained in contact with the alcohol for two or three days (or for a considerably longer period if mechanical agitation is not used) the clear liquid is decanted and the residue is pressed in order to recover as much of the extract as possible. Other materials, such as sugar, glycerin, caramel (for coloring purposes), are then dissolved in the extract which, after filtering, is ready for bottling. The glycerin is added, supposedly for the purpose of acting as a binder in baking, but its value for this purpose has not been definitely established. Imitation vanilla extracts are dependent largely upon the use of vanillin. The odor of this product when used alone, however, is too delicate and usually synthetic coumarin is added. A proportion of one part coumarin to four to eight parts of vanillin is often used.

A formula given by Kessler is as follows: Vanillin, 7 ounces; coumarin, 1 ounce; cane sugar, 8 pounds; alcohol, 3 gallons; pure water to make 10 gallons and caramel to give desired color.

Lemon extract.—Lemon extract ranks second to vanilla in point of consumption. According to the Federal standard of purity, it must contain 5 per cent by volume of oil of lemon. The process of manufacture is very simple, consisting only in mixing the grain alcohol and essential oil in proper proportions, filtering, and bottling. Sometimes a small amount of color is added as the solution has but a faint yellow tint. The chief cost in the manufacture of lemon extract is for the alcohol, since comparatively strong alcohol (at least 85 per cent) must be used in order to hold the lemon oil in solution.

Lemon oil (see Tariff Information Survey of Essential Oils of Citrus Fruits, par. 46) consists of a number of constituents, of which the inert terpenes compose about 90 per cent, the balance being made up of 4 to 6 per cent of citral and other aldehydes, and 4 to 6 per cent of alcohols, esters, and other compounds. Terpeneless oil of lemon is largely used in the manufacture of the so-called terpeneless lemon extract. Since it possesses the advantage of being soluble in dilute alcohol, the cost of production is considerably lower than that of lemon extract. According to the Federal standards for food products, terpeneless lemon extract must contain not less than 2 per cent by weight of citral, derived from oil of lemon. Cheap lemon extracts are sometimes made by repeatedly washing lemon oil with dilute alcohol (20 to 30 per cent). These products possess the same odor as other lemon extracts, but are considered entirely worthless for baking purposes.

Orange extract.—Orange extract is made in the same manner as lemon extract, but the production of cheaper grades is not so extensive, since the demand for orange extract is comparatively small.

Almond extract.—Almond extract is prepared by dissolving the essential oil of bitter almonds in strong alcohol, and in order to comply with the official standards it must contain at least 1 per cent by volume of this oil. Oil of bitter almonds (see Tariff Information Survey of Almond Oils, pars. 45 and 46) is derived principally from the seeds of apricots and also from peach kernels. Artificial almond extracts are prepared chiefly from the coal-tar product, benzaldehyde.

Peppermint and wintergreen extracts.—These extracts are largely used in confectionery, but are not often met on the general market. Both are made by dissolving the natural essential oils in alcohol. Since the pure extracts are practically colorless, they are usually colored artificially. The natural oil of wintergreen has been largely replaced by the synthetic methyl salicylate, which is extensively used in the preparation of the cheap wintergreen extracts. When so used, however, the product must be labeled "imitation" or "artificial."

Imitation extracts and artificial fruit essences.—It is impossible commercially to prepare flavoring extracts from certain common fruits and it is therefore necessary to reproduce their flavors by artificial means. This is usually accomplished by the use of certain organic chemicals known as the alkyl esters, which are prepared from fusel oil and other higher alcohols. These materials were extensively used in the past, especially for manufacturing purposes. They are, however, inferior to the concentrated juices and extracts from the real fruits, and since the passage of the food and drugs act their use has

largely been abandoned. The principal artificial fruit essences are as follows: pineapple, which is chemically ethyl butyrate; quince essence, which is chemically ethyl pelargonate (oenanthic ether); jargonelle pear essence, which is commercially sold under the name of banana oil, is chemically amyl acetate; apple essence, which is chemically amyl valerate.

The second class of synthetic flavoring materials are those derived from coal-tar products. Such products as methyl salicylate, benzaldehyde, and synthetic coumarin have large and legitimate uses as flavoring materials. The principal coal-tar products used for flavoring purposes, according to Pickrell's classification,[1] are as follows: Vanillin, coumarin, benzaldehyde, methyl cinnamate, ethyl cinnamate, ethyl benzoate, ethyl salicylate, and methyl salicylate. In addition to the above, the Tariff Commission, in its Census of Dyes and other Coal Tar Chemicals, has included saccharin among the coal-tar flavors. The principal flavors of coal-tar origin are discussed in greater detail in Tariff Information Survey of Natural and Synthetic Substances Used in the Manufacture of Perfumery and Cosmetics, paragraph 49. (See pages 73ff.)

Nonalcoholic flavors.—Flavors occasionally appear in commerce in the form of powders and pastes not containing alcohol. The powdered form is usually made by incorporating an essential oil with cane sugar and glycerin. An example given by Kessler consisted of granulated cane sugar, 65 pounds; oil of bitter almonds, 3 pounds; glycerin, C. P., 2 pounds.

Flavoring in paste form is similarly prepared, except that glycerin and glucose are added in sufficient quantities to form a smooth paste. These goods are packed and marketed in collapsible tubes. Attention should be called to the fact that notwithstanding the tariff provision for nonalcoholic flavoring extracts, these flavors are not entitled to the term "flavoring extracts" since the Department of Agriculture specifies that an extract is a solution in ethyl alcohol.

DOMESTIC PRODUCTION.

According to the Census of Manufactures in 1914, there were 424 establishments producing flavoring extracts and their total output was valued at $11,380,423. This represented an increase of about $2,500,000 over the output reported in 1909. Of the total number of establishments reported in 1914, 298 were assigned to other industries, principally those designated as coffee, spice, confectionery and ice cream, patent medicine and compounds, perfumery and cosmetics, and soap and baking powder. These establishments reported as subsidiary products flavoring extracts to the value of $4,762,617, or slightly less than one-half the total output.

The total capital invested in the industry was reported to be $6,617,000; 1,461 wage earners were employed, and the total wages paid was $689,000. Cost of materials was reported as $6,308,000, so that the total value added by manufacture represented $5,072,000. New York was the principal producing State with 119 establishments and an output of $2,352,000. Illinois ranked second with 25 establishments and an output of $1,400,000. Other important producing

[1] "Systematic Arrangement of the Articles Provided for in Chemical and Drug Schedule of the Tariff Act," E. R. Pickrell, chemist in charge, United States Appraisers Laboratory.

States in order of their importance, based on the value of the products, were as follows: Massachusetts, Missouri, Ohio, New Jersey, and California.

The industry, classed by the census as "cordials and flavoring sirup manufacturers," overlaps with the industry producing flavoring extracts, since it includes products reported as flavors for various liquors, coco cola, sirup, rock candy, tincture of ginger, etc.

Production of flavoring extracts of coal-tar origin have been reported by the United States Tariff Commission as follows:

Year.	Number of producers.	Quantity (pounds).	Value.
1917	6	779,416	$1,862,456
1918	7	458,256	4,925,627
1919	7	610,825	1,318,654

FOREIGN PRODUCTION.

England is probably the chief competitor of the American industry in foreign markets. Production statistics for the British industry are not available nor are the exports of flavoring extracts shown in detail in official British statistics.

Canada possesses a considerable flavoring extract industry, as shown by the survey recently made by the dominion bureau of statistics. This report[1] shows that 24 establishments had an output of flavoring extracts and essences valued at $301,242. In addition these factories produced baking powder, spices, jelly powders, yeast cakes, and a number of related products. The total invested capital for the industry was $2,259,753, of which the Province of Ontario contributed $1,725,000 and Quebec $347,000. Under the caption "Materials used" were noted the following:

	Cost at factory.
Essential oils, 21,667 pounds	$76,547
Alcohol, 21,179 gallons	92,602
Fruits, 154,563 quarts	29,030
Sugar, 1,406,767 pounds	124,477

EXPORTS.

The domestic exports of flavoring extracts and fruit juices have been shown separately in Commerce and Navigation only since 1914. Since that time, however, exports have increased in value from $106,892 in 1914, to $1,341,656 in 1919. The principal foreign consumers of American flavoring extracts are Canada, England, Cuba, Mexico, China, Japan, and the Latin American countries.

IMPORTS.

Imports of flavoring extracts, which have shown separately only since 1914, have been very small and of practically no significance as compared with domestic production and exports. From a quanti-

[1] Commerce Reports, No. 199, p. 931, Aug. 24, 1920.

tative viewpoint the largest imports of nonalcoholic flavoring extracts were received in 1918 and amounted to 3,596 pounds, valued at $6,426. In 1919, 3,428 pounds, valued at $11,290, were received.

The imports of alcoholic flavors are shown in three classes, based on the alcoholic content. The imports of flavoring extracts containing 20 per cent of alcohol or less, have been small and sporadic, and in 1917 reached a maximum of 1,288 pounds valued at $917. Imports of flavoring extract containing more than 20 but less than 50 per cent alcohol have ranged from 572 pounds in 1918, valued at $954, to 3 pounds in 1919, valued at $3. Imports of flavors of coal-tar origin have been shown in 1917, 1918, and 1919, and in the last-named year amounted to 160 pounds, valued at $816. Flavoring extracts containing more than 50 per cent alcohol have ranged from 10 pounds in 1914, valued at $24, to 338 pounds, in 1918, valued at $411.

TARIFF HISTORY.

Flavoring extracts were not mentioned specifically in the tariff acts prior to the act of 1913. In paragraph 16 of that act flavoring and other extracts and fruit essences containing 20 per cent alcohol or less became dutiable at 10 cents per pound and 20 per cent ad valorem. When containing more than 20 per cent and not more than 50 per cent of alcohol, 20 cents per pound and 20 per cent ad valorem, and those containing more than 50 per cent, 40 cents per pound and 20 per cent ad valorem. Paragraph 49 of the same act includes a provision for flavoring extracts not containing alcohol which are dutiable at 20 per cent ad valorem. In Group III, section 500, of the act of September 8, 1916, all flavors obtained, derived, or manufactured in whole or in part from products of coal-tar origin, are dutiable at 30 per cent ad valorem.

REFUND OF INTERNAL-REVENUE TAX FOR ALCOHOL USED IN THE MANUFACTURE OF FLAVORING EXTRACTS FOR EXPORT.

The tariff act of 1913 in paragraph O, Section IV, specifically mentions flavoring extracts as materials which, when manufactured for export, from domestic alcohol, shall be allowed a drawback equal in amount to the tax which has been paid on the alcohol used. There are no published statistics to show to exactly what extent the domestic manufacturers take advantage of this arrangement. Reports of the Commissioner of Internal Revenue include these figures with the drawback allowed on all exported articles, which includes distilled spirits, perfumery, etc. The total amount of drawback so allowed, however, amounted to about $350,000 during the fiscal year 1919, and to about $600,000 during the fiscal year 1920.

TARIFF CONSIDERATIONS.

The Department of Agriculture, in the administration of the food and drugs act, has defined a flavoring extract as a solution in ethyl alcohol. A product not containing alcohol is therefore not entitled to the term "flavoring extract." Paragraph 49 of the act of 1913, nevertheless, provides for "flavoring extract not containing alcohol." If Congress desires to continue the tariff provision for these articles

it is suggested that the term "flavor" be substituted for "flavoring extracts."

The imports of flavoring extracts of all kinds have been very small and of no significance as compared with the large domestic production and exports. The value of the imports and exports of flavoring extracts for the period 1914 to 1919 is shown in the following table:

Imports and exports of flavoring extracts.

Fiscal years.	Imports.					Exports.[1]
	Containing no alcohol.	Containing 20 per cent or less.	Containing 20 per cent but less than 50 per cent.	Containing more than 50 per cent.	Total imports.	
1914	$185	$81	$71	$24	$361	$106,892
1915	151	63	9	187	410	136,742
1916	619	.....	28	44	691	466,914
1917	7,691	917	647	164	9,419	581,550
1918	6,426	592	954	411	8,383	1,018,102
1919	11,290	.....	3	.....	11,293	[2]1,341,656
Total	26,362	1,653	1,712	830	30,557	3,651,856

[1] Exports of "flavoring extracts and fruit juices." [2] Calendar year.

The present specific duty in addition to the ad valorem duty on flavoring extracts and other alcoholic preparations is presumably for the purpose of counterbalancing the internal revenue tax on alcohol paid by the domestic manufacturers. At the time of the enactment of the tariff law, the excise tax was $1.10 per proof gallon, which was approximately equivalent to the following tax per pound:

For extracts containing—	Cents per pound.
20 per cent of alcohol	5½
50 per cent of alcohol	14¾
95 per cent of alcohol	31½

The war revenue act of 1918 increased the internal revenue tax on alcohol to $2.20 per proof gallon, or exactly twice the previous rate. This act also increased the duty on imported alcoholic perfumery by $1.10 per wine gallon, but it imposed no additional duty on alcoholic flavoring extracts.

However, in view of the small imports of flavoring extracts, it is questionable whether or not it is advisable, from an administrative point of view, to continue the compound rates as well as the present division of duties based on the alcoholic content. A single ad valorem rate or different specific rates based on alcoholic content might be preferable.

The Tariff Commission, in its report to Congress recommending certain amendments to Title V of the act of 1916 (see Dyes and Coal-Tar Chemicals, pp. 52–53, U. S. Tariff Commission, 1918), called attention to the advisability of mentioning specifically certain coal-tar flavors, such as saccharin, methyl salicylate, and coumarin. These articles are within the scope of the act of 1916 as well as provided for in the act of 1913, but under the decisions the two acts are to be read together respecting provisions of the 1913 act not expressly repealed in 1916, and the more specific provision given controlling

effect. The case of coumarin has been discussed in detail in the tariff information survey for "Natural and Synthetic Substances, Preparations, and Mixtures Used in the Manufacture of Perfumery," paragraph 49. (See page 86.)

Flavoring extracts—Production in United States.

[From Federal Census.]

Year.	Number of establishments.	Value of products.	Year.	Number of establishments.	Value of products.
1899	350	$6,308,000	1909	420	$8,828,000
1904	377	7,772,000	1914	424	11,380,000

Flavoring extracts—Production in United States, by States.

[From Federal Census.]

States.	1914		States.	1914	
	Number of establishments.	Value of products.		Number of establishments.	Value of products.
California	23	$439,193	New Jersey	19	$828,303
Colorado	3	14,202	New York	119	2,352,035
Georgia	4	53,703	Ohio	34	908,011
Illinois	27	1,400,777	Oregon	4	10,463
Iowa	8	114.316	Pennsylvania	34	379,224
Louisiana	3	51,452	Rhode Island	6	60.673
Maryland	15	166,944	Wisconsin	7	217,319
Massachusetts	35	1,164,733	All other	61	2,029,655
Michigan	10	180,837			
Missouri	12	1,008,583	Total	424	11,380,423

Flavoring extracts—Imports for consumption—Revenue.

NOT CONTAINING ALCOHOL.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	20 per cent	489	$185	$37	$0.378	20.00
1915	do	102	151	30	1.480	20.00
1916	do	973	619	123	.636	20.00
1917	do	2,895	7,691	1,538	2.657	20.00
1918	do	3,596	6,426	1,285	1.787	20.00
1919	do	3,428	11,290	2,258	3.293	20.00

CONTAINING 20 PER CENT ALCOHOL OR LESS.

1914	10 cents per pound plus 20 per cent.	81	$81	$24	$1.00	30.00
1915	do	56	63	18	1.13	28.89
1917	do	1,288	917	312	.71	34.05
1918	do	442	592	162	1.34	27.47

Flavoring extracts—Imports for consumption—Revenue—Continued.

CONTAINING MORE THAN 20 PER CENT AND NOT MORE THAN 50 PER CENT OF ALCOHOL.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	20 cents per pound plus 20 per cent.	57	$71	$25	$1.24	36.06
1915	do	12	9	4	.75	46.67
1916	do	7	28	7	4.00	25.00
1917	do	412	647	211	1.57	32.74
1918	do	572	954	305	1.67	31.99
1919	do	3	3	1	1.00	40.00

CONTAINING MORE THAN 50 PER CENT OF ALCOHOL.

1914	40 cents per pound plus 20 per cent.	10	$24	$8	$2.40	26.67
1915	do	194	187	115	.96	61.50
1916	do	48	44	28	.92	63.64
1917	do	168	164	100	.98	60.98
1918	do	338	411	217	1.22	52.90

FLAVORS OF COAL-TAR ORIGIN. (Act of 1916.)

1917	30 per cent	70	$560	$168	$8.00	30.00
1918	do	35	408	122	11.66	30.00
1919	do	160	816	244	5.10	30.00

Flavoring extracts and fruit juices—Domestic exports (fiscal years).

Exported to—	1914	1915	1916	1917	1918	1918 [1]	1919 [1]
France	$199	$28	$16,062	$2,980	$29,919	$31,851	$31,208
Netherlands	15	333	14,989	226	.....	.....	78,874
England	20,201	56,768	211,683	98,135	308,378	229,750	257,674
Canada	8,838	7,249	79,947	235,776	297,381	308,620	383,004
Panama	4,289	4,095	8,149	12,690	17,052	19,962	22,185
Mexico	11,213	4,527	8,521	29,948	35,612	35,816	60,796
Cuba	6,808	11,288	29,255	51,158	79,710	77,299	122,479
Argentina	373	686	7,043	8,513	15,245	23,514	10,773
Brazil	1,634	2,713	8,146	14,413	14,277	13,342	28,364
Colombia	5,143	6,707	5,046	10,343	13,004	12,408	22,960
Venezuela	5,101	5,999	7,300	8,458	10,043	11,481	17,643
China	665	1,390	1,480	2,491	10,948	14,459	33,294
British India	281	218	345	8,688	15,329	12,555	6,174
Japan	155	586	1,190	2,359	9,306	11,264	13,747
Australia	276	3,903	11,463	7,516	31,614	23,605	6,810
New Zealand	348	611	3,989	3,504	10,341	12,409	16,693
Philippines	8,583	8,135	10,859	9,484	13,477	16,186	35,160
All other	32,770	21,506	41,447	74,868	106,476	112,900	193,824
Total	106,892	136,742	466,914	581,550	1,018,102	967,421	1,341,656

[1] Calendar years.

Flavoring extracts—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1883	.....	Not specifically provided for	
1890	.....	do	
1894	.....	do	
1897	.....	do	
1909	.....	do	

Flavoring extracts—Rates of duty—Continued.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	16	* * * flavoring and other extracts and fruit essences, * * * if containing 20 per cent of alcohol or less.	10 cents per pound, 20 per cent ad valorem.
		Containing more than 20 per cent and not more than 50 per cent of alcohol.	20 cents per pound and 20 per cent ad valorem.
		Containing more than 50 per cent of alcohol.....	40 cents per pound and 20 per cent ad valorem.
	49	* * * flavoring extracts, * * * not containing alcohol and not specially provided for in this section.	20 per cent ad valorem.
1916	Sec. 500, Gr. III.	All * * * flavors * * * not otherwise specially provided for in this title, when obtained, derived, or manufactured in whole or in part from any of the products provided for in Groups I and II * * *. (NOTE.—Group I provides for distillates and other coal-tar "crudes" and Group II for coal-tar chemicals and "intermediates" for the manufacture of coal-tar dyes, stains, medicinals, photographic chemicals, flavors, and other related finished products.	30 per cent ad valorem.

COURT AND TREASURY DECISIONS.

Under the construction against implied repeal (Vandegrift *v.* United States, 9 Ct. Cust. Appls. 112; Decs. Treas. Dept., Oct. 5 and Nov. 7, 1916), saccharin is dutiable under the specific provision in paragraph 179 of the act of 1913 rather than under the provision for coal-tar medicinals or flavors in the act of September 8, 1916.

Coumarin shown by the evidence to be used chiefly in making flavoring extracts, was held dutiable as a chemical compound under paragraph 5 and not under paragraph 49 of the act of 1913 (Abstract 41691). (For further discussion of coumarin see survey upon perfumery materials.) But the provision for coal-tar flavors in Group III of section 500 of the act of September 8, 1916, was held to control over the general provision for chemical compounds in paragraph 5 of the act of 1913 (Abstract 43265).

Lavender flowers consisting of flowers of the lavender plant stripped from the stem and dried and used in part for the flavoring of tobacco, were held exempt from duty as crude drugs under paragraph 477 and not under paragraph 49 of the act of 1913 (Abstract 39004; followed in cases not involving use for flavoring tobacco, in Abstracts 40327, 41191 and 41192).

MISCELLANEOUS.

DRAWBACK PROVISION IN THE ACT OF 1913 RELATING TO THE MANUFACTURE OF FLAVORING EXTRACTS FOR EXPORTATION.

Section IV, par. O.

* * * * * * *

That on the exportation of flavoring extracts, medicinal or toilet preparations (including perfumery) hereafter manufactured or produced in the United States in part from domestic alcohol on which an internal-revenue tax has been paid, there shall be allowed a drawback equal in amount to the tax found to have been paid on the alcohol so used: *Provided*, That no other than domestic tax-paid alcohol shall have been used in the manufacture or production of such preparations. Such drawback shall be determined and paid under such rules and regulations, and upon the filing of such notices, bonds, bills of lading, and other evidence of payment of tax and exportation, as the Secretary of the Treasury shall prescribe.

* * * * *

MUSK, NATURAL AND SYNTHETIC.

(Par. 49, Act of 1913, 20 per cent ad valorem.)

SUMMARY.

Musk is the secretion of a certain gland of the male musk deer and in dried form it is used in the manufacture of perfumes and to a limited extent in medicine. Tonquin (or Tonkin), a French protectorate in Indo-China, is the chief source of supply, although occasional quantities are obtained from Russia and India. Musk enters commerce in two forms, either in the dried sacs or pods as taken from the deer, or the pods are opened and the musk removed, when it is known as *grain musk*. The musk pod sometimes contains as much as 2 ounces of pure musk, but the average is considerably less than an ounce. The chemical compound to which the odor of musk is due has not been definitely identified, although a product of coal-tar origin, known as *synthetic* or *artificial* musk, possesses a similar odor and is largely used as a substitute for the natural product. The sacs taken from the common muskrat are sometimes known as "American musk," and although possessed of a different odor can be substituted for musk in certain uses. Musk is one of the higher-priced perfume materials and normally sells for $15 to $30 per ounce. For this reason it is frequently adulterated.

China annually exports about a half million dollars' worth of crude musk. France has usually been the largest importer of Chinese musk, but in 1915 the United States was the largest consumer, taking about one-fourth of the year's product. Imports of musk into the United States have shown wide variation. The maximum import of musk pods in recent years occurred in 1913, when 12,994 ounces, valued at $124,855, were received. In 1914 only 3,209 ounces were imported, but the imports exceeded 10,000 ounces in 1915, 1917, and 1919. The importation of grain musk in 1917 was valued at $63,304. Imports in 1918 were valued at $29,246, but with the exception of these two years the value of the annual imports of grain musk has never exceeded $8,000. In 1914 imports of synthetic musk amounted to 8,962 pounds, valued at $9,351.

Crude musk in the natural pods was given specific enumeration in the free lists of the acts of 1883, 1890, 1894, 1897, and 1909. Grain musk, however, was not included in this provision and imports were held dutiable as a nonenumerated unmanufactured article at 10 per cent ad valorem. Paragraph 49 of the act of 1913 provided for both musk pods and grain musk at the uniform rate of 20 per cent ad valorem. Synthetic or artificial musk was held dutiable as a chemical compound under the act of 1897, but in the act of 1913, lacking specific enumeration, it would presumably fall in the class of "synthetic odoriferous substances * * * used in the manufacture of, but not marketable as, perfumes or cosmetics," dutiable at 20 per cent ad valorem.

Natural musk is not produced in the United States and the duty imposed by the act of 1913 was evidently for revenue purposes. The maximum annual revenue from both varieties of musk was obtained in 1917 and amounted to $28,665.

General Information.

PROVISIONS IN THE ACT OF 1913.

"49. * * * musk, grained or in pods, * * * and all * * * synthetic odoriferous or aromatic substances, * * * used in the manufacture of, but not marketable as, perfumes or cosmetics; all of the foregoing not containing alcohol and not specially provided for in this section, 20 per centum ad valorem."

DESCRIPTION AND USES.

Musk, the oldest of the perfume materials, is the dried secretion of the preputial follicles of the male musk deer (*Moschus moschiferus* Linné; family, Moschidae). Grained musk, which is one of the common forms in which this material enters commerce, consists of "small irregular granules, not more than eight-hundredths of an inch in thickness, blackish with a few brown fragments and becoming somewhat grayish on ageing, glistening, and slightly oily, and with a peculiar, penetrating, powerful, and persistent odor."[1] Musk is often marketed in its original form, in what is known as a pod, which is a small, contracted skin pouch, seldom larger than a walnut. The average weight of a musk sac is 394 grains (0.93 ounce), of which about 157 grains are musk. Sometimes, however, a pod may contain as much as 2 ounces of musk. The musks of Tonkin and Nakin are the finest. That of India has an odor like civet and is less esteemed, while the Russian or Siberian musk (called cabardine) is the least valuable.

Musk is of chief value as an ingredient of perfumes; its scent is more penetrating and persistent than that of any other known substance. It adds strength and persistency to vegetable essences, and is an ingredient in many compounded perfumes. The odor is so strong that one part of musk communicates its odor to 3,000 parts of inodorous powder. Musk was formerly considered a valuable remedy in hiccoughs and some laryngeal affections, but owing to its variable quality and high price it is falling into disuse in medicine. It is a favorite Chinese remedy and is also used in China to keep moths out of furs and clothing. Musk is official in the United States Pharmacopœia, IX.

Synthetic or artificial musk is a white crystalline powder made by a patented process. Although it possesses the musk odor it is not of the same chemical constitution; the chemical substance to which musk owes its odor has not been identified. Original synthetic musk was a trinitro derivative of toluene and later a similar preparation from xylene was used. Related substances such as dinitrobutylxylylazoimide and trinitroisobutyltoluene are also sold as artificial musk.[2]

[1] U. S. Pharmacopœia, IX, p. 277.

[2] Reference should be made to the later survey dealing with "Natural and synthetic odoriferous substances, preparations, and mixtures." (See page 83.)

Musk, owing to its high price, is one of the most frequently adulterated perfume materials, and the variety of substances used as adulterants is too wide to catalogue here. Artificial "musk sacs" are frequently ma de from hides and filled with a little genuine musk and much factitious substance. Certain kinds of adulteration can hardly be detected by casual examination, and in consequence it is considered a good average if in a year's purchases as much as 80 per cent of pure musk is obtained.

PRODUCTION AND TRADE.

The musk deer is a small animal found in the mountains and tablelands of Central Asia, from Anam in Farther India, northwestward to Tibet, and northward in China and Tartary to Manchuria and Southern Siberia. The animal is taken for its hide and musk, chiefly for the latter. Only male animals produce musk, and young and very old ones produce little or none. The musk deer is usually captured by the natives in traps; the sac or "pod" is removed and dried. Four principal varieties are recognized.

Tonkin or Tonquin musk, the most valued and principal sort, is a product of Tibet; it enters commerce almost wholly through China. Blueskin musk is a variety of this.

Cabardine musk is markedly inferior to the Tonkin; there are two varieties of this. The Chinese comes from China; it is a better product than Russian musk, which comes from Siberia via Petrograd.

Nepaul and Assam musk are very rare in Occidental commerce, occurring occasionally in England.

Chinese musk trade.—The chief center of the world's musk market is at Tachienlu, West Szechuan, the musk being collected principally on the Tibetau-Chinese frontier. Tachienlu is credited with handling in the neighborhood of a half million dollars' worth of musk annually. The nearest customs port is Chungking, from which the average export is about 3,000 pounds. Most of the export goes to France, and certain of the large French perfume manufacturers have representatives stationed at Tachienlu in order to secure the best quality of the material.

The musk deer are becoming more scarce each year, and at the present rate of destruction their extermination is not far distant. Each musk pod means that a male musk deer has been killed. However, in taking the animals the females and young deer are killed indiscriminately, and it is estimated that more than 100,000 deer are slaughtered annually to supply the musk market of the towns along the Tibet border. The exports of musk from China, according to United States consular reports, has been as follows:

Year.	Quantity.	Value.
	Ounces.	
1914	23,331	$250,310
1915	26,367	263,365
1916	25,190	427,354
1917	21,272	544,592

Although France has usually been the largest importer of Chinese musk, in 1915 the United States stood first, taking about one-fourth of the entire year's production.

Domestic production.—There is no domestic production of natural musk. Sacs taken from the common muskrat have been used as a substitute. This product, known as "American musk," possesses certain of the properties of the genuine musk, and although its odor is not identical it can be used in perfumery to a limited extent.

Imports.—The import of crude musk in natural pods in 1913 was 12,994 ounces, valued at $124,855; in 1918 it was 5,516 ounces, valued at $33,970, and yielded a revenue of $6,794. The import of grain musk in 1913 was valued at $7,699 and yielded a revenue of $769; in 1917 it increased to $63,304 and the revenue amounted to $12,660. Imports of grain musk fell to $29,246 in 1918 and in 1919 still further decreased to 6,269 ounces, valued at $7,158. The imports of musk in pods during 1919 amounted to 10,240 ounces, but the value increased to $176,108 ($17.20 per ounce).

The imports in 1914, according to the Census of Chemical Imports (Dept. of Commerce, Misc. Series 82), were received from the following sources:

Natural musk.

In pods:	Per cent.	In grain:	Per cent.
Canada	95.6	Germany	98.6
England	4.4	Hongkong	1.4

Artificial musk.

			Value.
Tri-nitro-meta-butyl-toluene	pounds	6,667	$6,174
Switzerland	per cent	60.5	
France	do	20.7	
Belgium	do	9.8	
Germany	do	9.0	
Tri-nitro-meta-butyl-xylene	pounds	1,907	1,684
France	per cent	100.0	
Artificial musk, extra soluble	pounds	388	1,493
Switzerland	per cent	100.0	

Prices.—Wholesale prices are quoted for several varieties of natural musk, among the most important of which are Tonquin and Cabardine pods and grains. Tonquin or Chinese musk pods sold for $13–$15 per ounce from 1912 until the beginning of 1917, when the price rose to $17.50. Since that time there has been a gradual increase until in July, 1920, quotations had reached $32–$34. Tonquin grain musk has followed somewhat the same trend. In January, 1917, it rose from $16 to $25 and continued to increase until in July, 1920, it had reached $50 per ounce. Cabardine musk is less expensive. The pods sold for about $8 per ounce prior to 1917, but have since increased to about $20. Grain Cabardine musk increased from $12 to $16 in January, 1917, and during the last quarter of 1919 and the first half of 1920 it further increased to $28 per ounce. Synthetic musk sold for $1.75–$3 per pound prior to the outbreak of the European war. During the last quarter of 1914 the price jumped to about $5 per pound, and this price was practically doubled during 1915. In January, 1918, the price suddenly rose from $11.50 to $30, and this price was maintained during most of 1918 and 1919. During the last quarter of 1919 the price dropped to $13–$15 and this price has been maintained during the first three quarters of 1920.

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The average prices which have prevailed in Tachienlu in recent years are as follows:[1]

Year.	Average price, in taels per ounce.	Value of tael.	Average price in United States equivalents.
1914	15	$0.67	$10.00
1915	13	.62	8.06
1916	11	.79	8.70
1917	11–12	1.03	11.35–12.36
1918	11–12	1.10	12.10–13.20
1919	12–24	1.20	14.40–28.80

TARIFF HISTORY.

Crude musk in natural pods was mentioned specifically on the free list of the act of 1883, and this provision remained unchanged in the acts of 1890, 1894, 1897, and 1909. Musk in grain was held not to be included in this provision, but classable as a nonenumerated unmanufactured article and dutiable at 10 per cent ad valorem. (See T. D. 8962.) The act of 1913 included specific provisions for both the grained musk and that in pods and provided a uniform rate of 20 per cent ad valorem.

Artificial musk was held to be a chemical compound n. s. p. f. under paragraph 3 of the act of 1897, dutiable at 25 per cent ad valorem. (See T. D. 26693.) This rate was not changed until the act of 1913 in paragraph 5 reduced it to 15 per cent.

TARIFF CONSIDERATIONS.

Natural musk is not obtainable from domestic sources and the duty provided by the act of 1913 was presumably for the purpose of raising revenue. The maximum annual revenue from musk grained and in pods was obtained in 1917 and amounted to $28,665.

Musk, crude, in natural pods.—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Ounces.				*Per cent.*
1908	Free	9,295	$81,599		$8.78	
1909	do	5,464	38,271		7.00	
1910	do	9,388	56,322		6.00	
1911	do	8,823	71,739		8.13	
1912	do	5,231	46,720		8.92	
1913	do	12,994	124,855		9.61	
1914	do	889	6,445		7.25	
1914	20 per cent	2,320	22,607	$4,521	9.74	20
1915	do	10,115	65,882	13,176	6.51	20
1916	do	7,390	62,094	12,418	8.40	20
1917	do	12,415	80,026	16,005	6.44	20
1918	do	5,516	33,970	6,794	6.15	20
1919	do	10,240	176,108	35,222	17.20	20

[1] See Commerce Reports, p. 262, Jan. 14, 1920.

Musk in grain—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Ounces.				*Per cent.*
1908	10 per cent		$3,505	$350		10
1909	do		2,208	220		10
1910	do		1,169	116		10
1911	do		4,119	411		10
1912	do		4,964	496		10
1913	do		7,699	769		10
1914	do		61	6		10
1914	20 per cent		3,930	786		20
1915	do		665	133		20
1916	do		534	106		20
1917	do		63,304	12,660		20
1918	do		29,246	5,849		20
1919	do	6,269	7,158	1,431	$1.15	20

Musk pods, Tonquin—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$13.00-$16.00	July, 1916	$13.00-$15.00
Apr. 1, 1912	13.00- 16.00	October, 1916	13.00- 15.00
July 1, 1912	13.00- 16.00	January, 1917	15.50- 16.00
Sept. 30, 1912	13.00- 15.00	April, 1917	16.50- 17.50
Dec. 30, 1912	13.00- 15.00	July, 1917	20.00- 20.50
Mar. 29, 1913	13.00- 15.00	October, 1917	20.00- 20.50
June 30, 1913	13.00- 15.00	Dec. 31, 1917	20.00- 20.50
Sept. 29, 1913	13.00- 15.00	Jan. 5, 1918	20.00- 20.50
Dec. 29, 1913	13.00- 15.00	Apr. 1, 1918	22.00- 22.50
Mar. 30, 1914	13.00- 15.00	July 1, 1918	24.00- 25.00
June 29, 1914	13.00- 15.00	Oct. 7, 1918	25.00- 26.50
August, 1914	13.00- 15.00	Jan. 6, 1919	25.00- 26.50
Oct. 1, 1914	13.00- 15.00	Apr. 7, 1919	27.50- 28.00
January, 1915	13.00- 15.00	July 7, 1919	28.00- 29.00
April, 1915	13.00- 15.00	Oct. 6, 1919	30.00- 32.00
July, 1915	13.00- 15.00	Jan. 5, 1920	30.00- 32.00
October, 1915	13.00- 15.00	Apr. 5, 1920	30.00- 32.00
January, 1916	13.00- 15.00	July 5, 1920	30.00- 32.00
April, 1916	13.00- 15.00		

Musk grain, Tonquin—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$16.00-$19.00	April, 1916	$16.00-$19.00
Apr. 1, 1912	16.00- 19.00	July, 1916	16.00- 19.00
July 1, 1912	16.00- 19.00	October, 1916	16.00- 19.00
Sept. 30, 1912	16.00- 19.00	January, 1917	25.00- 26.00
Dec. 30, 1912	16.00- 19.00	April, 1917	25.00- 26.00
Mar. 29, 1913	16.00- 19.00	July, 1917	29.50- 30.00
June 30, 1913	16.00- 19.00	October, 1917	29.50- 30.00
Sept. 29, 1913	16.00- 19.00	Dec. 31, 1917	21.50- 32.00
Dec. 29, 1913	16.00- 19.00	Jan. 5, 1918	31.50- 32.00
Mar. 30, 1914	16.00- 19.00	Apr. 1, 1918	33.50- 34.00
June 29, 1914	16.00- 19.00	July 1, 1918	38.00- 40.00
August, 1914	16.00- 19.00	Oct. 7, 1918	38.00- 40.00
Oct. 1, 1914	16.00- 19.00	Jan. 6, 1919	42.00- 43.00
January, 1915	16.00- 19.00	Apr. 7, 1919	38.00- 42.00
April, 1915	16.00- 19.00	July 7, 1919	42.00- 45.00
July, 1915	16.00- 19.00	Oct. 6, 1919	12.00- 13.00
July, 1915	16.00- 19.00	Jan. 5, 1920	46.00- 50.00
October, 1915	16.00- 19.00	Apr. 5, 1920	48.00- 50.00
January, 1916	16.00- 19.00	July 5, 1920	46.00- 50.00

Musk pods, Cabardine—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$8.00–$8.50	July, 1916	$8.00–$8.50
Apr. 1, 1912	8.00– 8.50	October, 1916	8.00– 8.50
July, 1912	8.00– 8.50	January, 1917	10.00–10.50
Sept. 30, 1912	8.00– 8.50	April, 1917	10.00–10.50
Dec. 30, 1912	8.00– 8.50	July, 1917	10.00–10.50
Mar. 29, 1913	8.00– 8.50	October, 1917	10.00–10.50
June 30, 1913	8.00– 8.50	Dec. 31, 1917	10.00–10.50
Sept. 29, 1913	8.00– 8.50	Jan. 5, 1918	10.00–10.50
Dec. 29, 1913	8.00– 8.50	Apr. 1, 1918	10.00–10.50
Mar. 30, 1914	8.00– 8.50	July 1, 1918	12.00–12.50
June 29, 1914	8.00– 8.50	Oct. 7, 1918	12.00–12.50
August, 1914	8.00– 8.50	Jan. 6, 1919	12.00–12.50
Oct. 1, 1914	8.00– 8.50	Apr. 7, 1919	12.00–12.50
January, 1915	8.00– 8.50	July 7, 1919	12.00–12.50
April, 1915	8.00– 8.50	Oct. 6, 1919	15.00–16.00
July, 1915	8.00– 8.50	Jan. 5, 1920	18.00–20.00
October, 1915	8.00– 8.50	Apr. 5, 1920	18.00–20.00
January, 1916	8.00– 8.50	July 5, 1920	18.00–20.00
April, 1916	8.00– 8.50		

Musk grain, Cabardine—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$12.00–$15.00	July, 1916	$12.00–$15.00
Apr. 1, 1912	12.00– 15.00	October, 1916	12.00– 15.00
July 1, 1912	12.00– 15.00	January, 1917	16.00– 17.00
Sept. 30, 1912	12.00– 15.00	April, 1917	16.00– 17.00
Dec. 30, 1912	12.00– 15.00	July, 1917	16.50– 17.00
Mar. 29, 1913	12.00– 15.00	October, 1917	16.50– 17.00
June 30, 1913	12.00– 15.00	Dec. 31, 1917	18.50– 19.00
Sept. 29, 1913	12.00– 15.00	Jan. 5, 1918	18.50– 19.00
Dec. 29, 1913	12.00– 15.00	Apr. 1, 1918	18.50– 19.00
Mar. 30, 1914	12.00– 15.00	July 1, 1918	18.50– 19.00
June 29, 1914	12.00– 15.00	Oct. 7, 1918	18.50– 19.00
August, 1914	12.00– 15.00	Jan. 6, 1919	18.50– 19.00
Oct. 1, 1914	12.00– 15.00	Apr. 7, 1919	18.50– 19.00
January, 1915	12.00– 15.00	July 7, 1919	18.50– 19.00
April, 1915	12.00– 15.00	Oct. 6, 1919	24.00– 25.00
July, 1915	12.00– 15.00	Jan. 5, 1920	28.00– 29.00
October, 1915	12.00– 15.00	Apr. 5, 1920	28.00– 29.00
January, 1916	12.00– 15.00	July 5, 1920	28.00– 29.00
April, 1916	12.00– 15.00		

Musk pods druggists'—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$16.00–$16.00	January, 1916	$16.00–$16.50
Apr. 1, 1912	16.00– 16.50	April, 1916	16.00– 16.50
July 1, 1912	16.00– 16.50	July, 1916	16.00– 16.50
Sept. 30, 1912	16.00– 16.50	October, 1916	16.00– 16.50
Dec. 30, 1912	16.00– 16.50	January, 1917	23.00– 24.00
Mar. 29, 1913	16.00– 16.50	April, 1917	23.00– 24.00
June 30, 1913	16.00– 16.50	July, 1917	27.50– 28.00
Sept. 29, 1913	16.00– 16.50	October, 1917	27.50– 28.00
Dec. 29, 1913	16.00– 16.50	Dec. 31, 1917	29.50– 30.00
Mar. 30, 1914	16.00– 16.50	Jan. 5, 1918	29.50– 30.00
June 29, 1914	16.00– 16.50	Apr. 1, 1918	Nominal.
August, 1914	16.00– 16.50	July 1, 1918	Nominal.
Oct. 1, 1914	16.00– 16.50	Oct. 7, 1918	Nominal.
January, 1915	16.00– 16.50	Jan. 6, 1919	Nominal.
April, 1915	16.00– 16.50	Apr. 7, 1919	Nominal.
July, 1915	16.00– 16.50	July 7, 1919	Nominal.
October, 1915	16.00– 16.50	Oct. 6, 1919	Nominal.

Musk pods, synthetic—Prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$1.75– $3.00	July, 1916	$11.50–$12.00
Apr. 1, 1912	1.75– 3.00	October, 1916	11.50– 12.50
July 1, 1912	1.75– 3.00	January, 1917	11.50– 13.00
Sept. 30, 1912	1.75– 3.00	April, 1917	11.50– 13.00
Dec. 30, 1912	1.75– 3.00	July, 1917	11.50– 13.00
Mar. 29, 1913	1.75– 3.00	October, 1917	11.50– 13.00
June 30, 1913	1.75– 3.00	Dec. 31, 1917	11.50– 13.00
Sept. 29, 1913	1.75– 3.00	Jan. 5, 1918	11.50– 13.00
Dec. 29, 1913	1.75– 3.00	Apr. 1, 1918	30.00
Mar. 30, 1914	1.75– 3.00	July 1, 1918	30.00
June 29, 1914	1.75– 3.00	Oct. 7, 1918	30.00
August, 1914	1.75– 3.00	Jan. 6, 1919	30.00
Oct. 1, 1914	4.00– 5.00	Apr. 7, 1919	30.00
January, 1915	4.00– 5.00	July 7, 1919	25.00– 28.00
April, 1915	4.50– 5.50	Oct. 6, 1919	25.00– 28.00
July, 1915	8.50– 9.00	Jan. 5, 1920	13.00– 15.00
October, 1915	8.50– 9.00	Apr. 5, 1920	13.00– 15.00
January, 1916	8.50– 9.00	July 5, 1920	13.00– 15.00
April, 1916	8.50– 9.00		

Musk, natural and synthetic—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	506	Musk, crude, in natural pod	Free.
1890	654	Musk, crude, in natural pods	Do.
1894	559	.....do	Do.
1897	618	.....do	Do.
1909	631	.....do	Do.
1913	49	* * * musk, grained or in pods, * * * all natural or synthetic odoriferous or aromatic substances, preparations, and mixtures used in the manufacture of, but not marketable as, perfumes or cosmetics: all the foregoing not containing alcohol and not specially provided for in this section.	20 per cent.

Court and Treasury Decisions.

Musk in the grain is held dutiable as an unenumerated unmanufactured article and not as crude musk in the natural pod under the act of 1883. (T. D. 8962.)

Artificial musk, which chemically is tri-nitro-iso butylxylol, being the result of the combination of 106 parts of xylol, 74 parts of iso butyl alcohol, and 189 parts of nitric acid, the xylol being the only coal-tar derivative in the body, was held properly classified as a chemical compound under paragraph 3 of the act of 1897, and not as a coal-tar product or preparation under paragraph 15. (G. A. 6148, T. D. 26693; T. D. 28582, suit 4123.)

In another case, in which additional evidence was offered on behalf of the importers, the artificial musk was similarly classified. (G. A. 7161, T. D. 31269; Magnus *v.* 1 Ct. Cust. Appls., 166.)

CIVET.

General Information.

PROVISION IN THE ACT OF 1913.

49. * * * civet, * * * all the foregoing not containing alcohol, * * * 20 per centum ad valorem.

DESCRIPTION AND USES.

Civet is an odorous substance obtained as a secretion from both the male and female of the civet cat. The civet cat of Africa (*Viverra civetta*) and the species found in the East Indies (*V. zibetha*) furnish the bulk of the civet of commerce, although occasionally supplies are received from Java, China, and the Malabar coast. Civet is an unctuous, semiliquid substance, yellowish in color, becoming brown on exposure to air, and of an unpleasant and bitter taste. The concentrated material has a very objectionable odor, but when diluted the disagreeable odor disappears, and it becomes a valuable fixative for perfumery.

Commercial civet is occasionally adulterated with vaseline or a fatty substance such as coconut butter. Substitutes are now produced synthetically which resemble civet in odor or in its fixative properties. These are available in liquid or crystalline form.

Civet is used exclusively in the manufacture of perfumery and cosmetics. It was formerly used to some extent in medicine.

The article shown in the import statistics under the caption "civet oil" is undoubtedly the same sort of material elsewhere classed as "civet." Civet itself is an oily semiliquid substance, but "civet oil" is not known to commerce or to science.

PRODUCTION AND TRADE.

There are a number of species of civet cats, of which the following are the more important: *Viverra civella* (African), *V. zibetha* (Indian), *V. civellina* (Malabar coast), *V. megaspels* (Burmese), *V. tangalungo* (Javan), and *V. malaccenses* (Chinese). The African civet cat furnishes the largest proportion of civet of commerce; its product is exported principally from Abyssinia. London, Paris, Hamburg, and New York are the principal markets.

The civet cat has two well-defined civet glands forming a deep pouch in the posterior portion of the abdomen. The pouch is divided into two sacs, each the size of a marble, in which the civet is secreted. The cats are kept in confinement for the purpose of collecting their civet, which is removed from the cats by means of a small spatula

at intervals of about four days. The male yields 1 to 1½ drams and the female ½ to 1 dram. Civet is packed in horns holding about 30 ounces.

IMPORTS.

Imports of civet in 1911 amounted to 27,086 ounces, valued at $7,850, and were admitted free of duty. In 1913 the quantity of civet imported was considerably less than in 1911, although the total value was more than double that in 1911. In 1914 and 1915 imports fell to about 2,200 ounces; in 1916, 1917, and 1918 the average annual import was about 9,500 ounces. During 1919 15,315 ounces, valued at $17,253, were received.

Imports classified as "civet oil" were reported during 1912, 1913, 1914, 1915, 1918, and 1919, and ranged between 250 ounces, valued at $392, in 1914 and 5,181 ounces, valued at $7,365, in 1915.

As previously noted these imports are believed to be no different from the material elsewhere classed as "civet."

PRICES.

The price of civet has been remarkably stable for an imported perfume material. From January, 1912, until the outbreak of the European war civet was quoted at $1.50 to $2 per ounce. The price then rose to $2 and $2.25, and this price obtained for three years. Since January, 1918, there has been a slight increase and prices have ranged between $2.25 and $3.25.

TARIFF HISTORY.

Crude civet was mentioned specifically on the free list of the act of 1883, and this provision was included in the free list of succeeding tariff acts until 1913. In the act of 1913 civet became dutiable at 20 per cent ad valorem.

TARIFF CONSIDERATIONS.

Civet presents no particular tariff problem. The natural material is not obtainable from domestic sources, and although synthetic substitutes are manufactured in this country they can not replace the genuine civet in all of its uses. The article is also unimportant from a revenue viewpoint; the maximum annual revenue received in 1919 amounted to $3,451.

Attention should be called to the provision for "civet oil." This material is not a recognized article of commerce, but is believed to be identical with civet itself. Both provisions carry the same rate of duty and accordingly there is no loss of revenue. To simplify and correct the classification for civet, however, the provision for "civet oil" might be omitted in future tariff revisions.

Civet, crude—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Ounces.				*Per cent.*
1908	Free	13,415	$18,182		$1.35	
1909	do	2,584	2,717		1.05	
1910	do	5,888	5,715		.97	
1911	do	27,086	7,850		.29	
1912	do	5,039	6,725		1.33	
1913	do	11,269	15,557		1.38	
1914	do	2,004	3,150		1.57	
1914	20 per cent [1]	757	828	$165	1.09	20
1915	do	1,820	2,086	417	1.14	20
1916	do	9,600	12,099	2,419	1.26	20
1917	do	9,230	13,148	2,629	1.42	20
1918	do	9,766	11,877	2,375	1.21	20
1919	do	15,315	17,253	3,451	1.12	20

[1] Not containing alcohol and n. s. p. f.

Civet oil—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Ounces.				*Per cent.*
1912	Free	992	$1,225		$1.23	
1913	do	1,155	1,688		1.46	
1914	do	130	170		1.30	
1914	20 per cent	120	222	$44	1.85	20
1915	do	5,181	7,365	1,473	1.42	20
1918	do	3,277	5,136	1,027	1.56	20
1919	do	361	890	178	2.47	20

Civet—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$1.50–$2.00	July, 1916	$2.00–$2.25
Apr. 1, 1912	1.50– 2.00	October, 1916	2.00– 2.25
July 1, 1912	1.50– 2.00	January, 1917	2.00– 2.25
Sept. 30, 1912	1.50– 2.00	April, 1917	2.00– 2.25
Dec. 30, 1912	1.50– 3.00	July, 1917	2.00– 2.25
Mar. 29, 1913	1.50– 2.00	October, 1917	2.00– 2.25
June 30, 1913	1.50– 2.00	Dec. 31, 1917	2.25– 2.35
Sept. 29, 1913	1.50– 2.00	January, 1918	2.25– 2.35
Dec. 29, 1913	1.50– 2.00	April, 1918	2.50– 2.75
Mar. 30, 1914	1.50– 2.00	July, 1918	2.50– 2.75
June 29, 1914	1.50– 2.00	October, 1918	2.50= 2.75
Aug., 1914	1.50– 2.00	January, 1919	3.00– 3.25
Oct. 1, 1914	2.00– 2.23	April, 1919	3.00– 3.25
January, 1915	2.00– 2.25	July, 1919	3.00– 3.25
April, 1915	2.00– 2.25	October, 1919	3.00– 3.25
July, 1915	2.00– 2.25	January, 1920	2.50– 3.25
October, 1915	2.00– 2.25	April, 1920	2.75– 3.00
January, 1916	2.00– 2.25	July, 1920	3.00– 3.25
April, 1916	2.00– 2.25		

Civet—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	507	Civet, crude	Free.
1890	534	do	Do.
1894	437	do	Do.
1897	521	do	Do.
1909	533	do	Do.
1913	49	* * * civet, * * * all the foregoing not containing alcohol * * *.	20 per cent.

NATURAL AND SYNTHETIC ODORIFEROUS SUBSTANCES, PREPARATIONS, AND MIXTURES.

(Par. 49, Act of 1913, 20 per cent ad valorem.)

SUMMARY.

The articles discussed here are the odorous substances and preparations used in the manufacture of perfumes and cosmetics, described in the tariff as "all natural or synthetic odoriferous or aromatic substances, preparations, and mixtures used in the manufacture of, but not marketable as, perfumes or cosmetics." This provision included for the first time in the act of 1913 is so framed as to cover all nonalcoholic perfume materials other than the essential and distilled oils and the natural and chemical products elsewhere specifically provided for. The materials thus included are the products of two distinct branches of the perfume industry, viz, (1) the manufacture of the so-called synthetic aromatic chemicals, useful only as raw materials for perfumery, and (2) the blending and compounding of mixtures and preparations consisting of a number of chemicals or natural floral products, or combinations of both.

(1) The synthetic aromatic chemicals are definite chemical bodies which have been manufactured from other chemical products, such as the coal-tar distillates, or have been derived, directly or indirectly from the essential oils or similar natural products. They closely resemble and in some cases are chemically identical with the odorous principles of these natural materials. Others differ in chemical composition from the flower or plant constituents, but possess similar odors.

(2) The mixtures and preparations which comprise the second of the two classes of perfume materials are made up of a number of constituents blended together in the proper proportions to simulate the various flower odors. Certain of these mixtures are of known composition, but in most cases their formulæ are guarded as trade secrets. They are of widely different character and represent various degrees of manufacture. Some for instance, are highly manufactured in that the materials have been so completely blended and compounded that simply by adding alcohol they may be converted into finished perfume. This is not true in the case of the aromatic chemicals or of the essential oils, since these products must be blended or compounded with other perfume materials before a finished perfume can be obtained. In other words, the addition of alcohol is not sufficient to convert an aromatic chemical or essential oil into a commercial perfume. Practically every flower odor and essential oil is imitated with more or less success by a so-called "synthetic" or artificial product. In addition, the odors of certain flowers—the lily of the valley, honeysuckle, sweet pea, lilac, and trailing arbutus—can not be extracted commercially from natural sources—the flowers themselves—and must be produced synthetically. Other mixtures and compounded preparations used in large

quantities include those of the rose, violet, jasmine, hyacinth, carnation, geranium, and may-blossom types.

The aromatic chemicals may be divided into two classes: (1) Those obtained as the result of organic synthesis from distillates or other products of coal-tar origin and (2) those obtained directly from the essential oils or prepared from such products by further manufacture. An example of a coal-tar aromatic chemical is artificial musk obtained from toluol (the base for the important explosive T. N. T.), by condensing it with isobutyl alcohol and subsequent nitration. Benzaldehyde, which is commonly known as artificial oil of bitter almonds, is a much simpler product of the same class and is also prepared from toluol. Other important coal-tar perfumes are benzyl acetate, an important odorous principle of the jasmine flower; diphenyl oxide, the artificial geranium odor; coumarin, the flavoring principle of tonka beans, and methyl salicylate, or artificial oil of wintergreen. Aromatic chemicals derived from the essential oils form the basis for the synthesis of many other perfume materials. Thus, citral, the odorous principle of lemon and lemongrass oils is isolated from the latter and by condensation with acetone is changed into another substance known as ionone. Ionone and its derivatives are widely used for reproducing the odor of violets. Heliotropin, the basis for odors of the heliotrope type, is prepared from safrol, a substance obtained from camphor and sassafras oils. Vanillin, which is the flavoring principle of vanilla extract, was at one time obtained exclusively from vanilla beans. It is now produced in large quantities by the oxidation of an aromatic chemical obtained from oil of cloves or it can be produced from guaiacol, a coal-tar product. The aromatic chemicals range in price from about $1 per pound, as in the case of methyl salicylate, to $50 per pound for artificial musk. Sales of other compounds at $100 per pound are not uncommon.

Since many of the mixtures and combinations contain some natural flower products, it is natural that France should attain supremacy in this particular field. The aromatic chemicals, however, were produced most largely in Germany where their manufacture became closely allied with that country's coal-tar dyestuff and chemical industries.

Certain products, such as vanillin, which are consumed on a large scale, were produced in the United States in considerable quantities before 1914. Several firms were also engaged in the manufacture of a number of other aromatic chemicals, but their total output was of little importance as compared with the imports of these materials. Production statistics for most of these materials have not been published. The census in 1914 reported the output of vanillin and amyl acetate, but other synthetic products were not shown in detail. Since 1917, the Tariff Commission has published an annual census of dyes and other coal-tar products which has included the perfumes and flavors of coal-tar origin. The output of coal-tar flavors in 1917 was 779,416 pounds valued at $1,862,456; in 1918, 458,256 pounds valued at $4,925,627; and in 1919, 610,825 pounds valued at $1,318,654. Coal-tar perfumes in 1917 were reported as 19,545 pounds valued at $125,961; in 1918, as 116,263 pounds valued at $584,695, and in 1919, 41,419 pounds valued at $164,302. In the case of both flavors and perfumes, the large increase in 1918 was caused by demand for certain articles for military purposes.

The imports of the bulk of these materials are included in the import statistics under the caption "Substances, preparations, and mixtures, odoriferous or aromatic, used in the preparation of perfumes or cosmetics, not specially provided for, not containing alcohol." The average value of the imports since 1915 has been about $500,000. In 1919 the quantity was shown for the first time, and amounted to 34,451 pounds. The census of chemical imports made by the Department of Commerce in 1914 showed that prior to the war at least 165 different articles were included under this head and in addition, there were about 20 coal-tar perfumes and flavors.

The tariff classification of these materials might be improved by a separate provision for the aromatic chemicals. As previously pointed out they differ widely from the other articles, in that they must be mixed with other perfume materials in order to obtain the finished perfumes. The articles which would then remain in the original provision, viz, the mixtures and combinations made up of essential oils, natural floral products, and aromatic chemicals, are in general more highly manufactured products which have been prepared under the direction of skilled perfumers. Many mixtures so prepared can be converted into finished perfumes simply by the addition of alcohol, and their importation affords a means of evading the higher duties on perfumes and toilet waters. (See Tariff Considerations, infra.)

General Information.

PROVISIONS IN THE ACT OF 1913.

PAR. 49. * * * and all natural or synthetic odoriferous or aromatic substances, preparations, and mixtures used in the manufacture of, but not marketable as, perfumes or cosmetics; all the foregoing not containing alcohol and not specially provided for in this section, 20 per centum ad valorem.

DESCRIPTION AND USES.

The articles included in the above provision comprise a large number of materials, differing widely in character and composition and oftentimes related only in the sense that all are raw materials for the manufacture of perfumes and cosmetics. For the purposes of this survey the group may be divided into the following subdivisions:

1. Aromatic chemicals.
2. Mixtures of natural floral products, or mixtures of aromatic chemicals or mixtures of both natural and chemical products.

1. The aromatic chemicals are of two general classes, viz, the constituents which appear in the natural product and are responsible for the perfume—such as *vanillin* in vanilla beans, and *methyl salicylate* in oil of wintergreen, or products of entirely different composition but which possess odors imitating those of natural products, such as is the case with artificial musk. In general, the aromatic chemicals must be carefully prepared and of the highest purity, since in many cases even the slightest traces of impurities have a pronounced effect on the odors of the final products. The aromatic chemicals may be (1) synthesized by chemical processes

from coal-tar or other chemical products, or (2) they may be derived in whole or in part from natural sources, such as the essentail oils. For example, *benzaldehyde*, the main constituent of oil of bitter almonds is prepared from the coal-tar distillate, *toluol*, while *ionone*, the basis of all synthetic violet perfumes, is manufactured from *citral*, a definite chemical substance isolated from oil of lemon grass.

The most important synthetic aromatic chemicals are discussed in detail in a later part of this report. (See pp. 82 to 93.)

2. The second of the two classes referred to above, namely, the natural and synthetic mixtures, can not be so easily defined. The first class is made up of definite chemical substances, which may be identified readily by means of well-known chemical and physical properties. The second class, on the other hand, consists of mixtures and combinations, each of which may be made up of a half dozen or more different natural or chemical constituents. Certain of these mixtures are of known composition, but in most cases they are marketed under trade names and their composition is guarded as trade secrets. There are a number of flowers, such as the lily of the valley, honeysuckle, sweet pea, and lilac, from which the odorous principles can not be extracted commercially, and for which the perfumer is dependent upon artificial means of reproduction. However, practically every flower odor and natural essential oil is imitated by a so-called "synthetic flower oil," which for certain purposes may be regarded as a more or less satisfactory substitute. The term "synthetic" as thus used is a misnomer, since these synthetic oils are usually mixtures of different constituents, some of which may themselves be synthesized, while others may have been isolated from essential oils or extracted from flowers. One class of these preparations of especial tariff interest is made up of highly manufactured products in which a large number of both natural and synthetic materials have been skilfully compounded to produce a product which can be converted into a finished perfume by the simple addition of alcohol. In other cases perhaps two or more of these preparations may be required for the finished perfume, but even then the preparation of the final product requires comparatively little skill.

HISTORY AND PRODUCTION OF SYNTHETIC PERFUMES.

The cultivation of natural perfume materials, because of climatic conditions and the large amount of actual hand labor involved has necessarily been limited to the few countries where these requirements can be met. Moreover, the flower crops vary widely from year to year and for this and other reasons supplies are irregular and the market is easily influenced. While the synthetic industry had its origin in the chemists' attempt to imitate flower odors which could not be extracted from the natural sources, it has led to the synthesis of numerous chemical compounds capable of replacing natural perfume and flavoring materials. As the methods of production were improved, in many cases synthetic products were developed which were not only cheaper, but because of greater purity and uniformity were actually superior to the natural products.

The first synthetic aromatic chemical was probably oil of myrbane (nitrobenzol), introduced by Collas about 1850 and still used to some extent as a substitute for benzaldehyde, the artificial oil of bitter almonds. Coumarin, the active principle of tonka beans and an im-

portant base for the odor of new-mown hay, was synthesized by Sir W. H. Perkin in 1867, and was followed later by heliotropine, which was prepared by oxidation of safrol, a substance found in camphor oil. The synthesis in 1876 of vanillin by Tiemann and Haarmann may, however, be said to have marked the real beginning of the synthetic industry. These chemists used the sap of a pine tree as the basis of their synthesis, but it has since been shown that vanillin can be more cheaply prepared by the oxidation of eugenol, a constituent in oil of cloves. Musk, one of the oldest and most important perfume materials, was synthesized by Dr. Albert Bauer in 1888. The first artificial musk was prepared from toluene, isobutyl alcohol, and nitric acid and, although of entirely different chemical composition, it possessed an odor practically identical with that of the natural product. This synthesis may be regarded as one of the most important accomplishments in the industry, and it has been followed by the discovery and development of a great many more synthetic aromatic chemicals. The present list includes several hundred different chemical compounds, and new products are constantly being added.

FOREIGN PRODUCTION.

The manufacture of synthetics on a commercial scale was begun by de Laire, who established a factory near Paris in 1876. In a short while the industry spread to Germany, where it made striking progress. There the industry became closely allied with the manufacture of dyestuffs, pharmaceuticals, and photographic chemicals, thus forming a unit in Germany's great coal-tar industry. Germany soon began to export large quantities of synthetics to England and America for use in the manufacture of toilet soaps and in cheaper grades of perfumery. France consumed the bulk of her own production in the manufacture of finished perfumery, which she exported to practically every country in the world. Both France and Switzerland have specialized to some extent in the manufacture of the more expensive mixtures and preparations, which were largely exported to the United States and Canada.

Justin du Pont, a French authority, in referring to the synthetic perfume industry at the outbreak of the war, made the following statement:

> At present all, or nearly all, of the large synthetic perfume factories of the world are located in France, Germany, Switzerland, and Holland. There are 8 in France, 12 in Germany, 4 in Switzerland, and 2 in Holland. England has met with some success in the industry, but her factories are largely concerned with the flavors and food materials. In Germany the synthetic perfume industry is closely tied up with the manufacture of dyestuffs, pharmaceuticals, and photographic chemicals.
>
> It is very easy to obtain an incorrect idea of the importance of the French industry if one relies upon the official statistics of the country's commerce. The value of the imports for the last three years before the war are given as follows: 1912, 1,424,000 francs; 1913, 1,429,000 francs; and 1914, 742,000 francs. The value of the exports are given as follows: 1912, 192,000 francs; 1913, 165,000 francs; and 1914, 373,000 francs. It is very obvious that these official figures, at least for the exports, are incorrect, since the least pretentious French factory annually exports more than the total indicated for the industry. This is due primarily to the fact that products are exported, not as "synthetic perfumes" but as "raw materials for perfumery," "chemical products," and "perfume chemicals." I estimate, and I believe very conservatively, that the official export figures for synthetic perfumes can be multiplied by from 25 to 30 in order to obtain the correct idea of the importance of the French commerce.

NOTE.—Import and export figures for Germany and France are shown on pages 94 and 95.

DOMESTIC PRODUCTION.

Prior to the war the domestic manufacture of synthetic perfume chemicals was carried on only to a very limited extent, and this country was dependent upon Germany for the larger proportion of our consumption of these articles. Products such as vanillin and coumarin, which are used in large quantities, were being manufactured on a considerable scale before 1914, and there were also several firms producing a number of synthetic perfume chemicals, but their total production contributed only a small part of our consumption. The production of vanillin was reported by the Census of Manufactures in 1914 to be 120,619 pounds, valued at $525,219. Other synthetic perfume materials are not shown in detail in the Census of Manufactures.

The United States Tariff Commission, in its census of dyes and coal-tar chemicals, has published the following totals for the domestic production of the synthetic aromatic chemicals of coal-tar origin:

Year.	Description.	Quantity.	Value.
		Pounds.	
1917	Flavors (coumarin, saccharin and methyl salicylate)	779,416	$1,862,456
	Perfume materials	19,545	125,961
1918	Flavors (coumarin, saccharin, ethyl benzoate)	458,256	4,925,627
	Perfume materials	116,263	[1] 584,695
1919	Flavors (coumarin, ethyl benzoate, ethyl salicylate and saccharin)	610,825	1,31°,654
	Perfume materials	41,419	164,302

[1] The large production during 1918 was caused by the fact that certain perfume chemicals, such as benzyl acetate (see p. 21) were used in considerable quantities for military purposes.

The synthetic aromatic chemicals of coal-tar origin produced in the United States during 1917, 1918, and 1919, are shown on page 94 in as great detail as can be published without revealing confidential information.

TRADE IN SYNTHETIC PERFUMES.

Imports.—Imports of these materials have been shown separately in the import statistics only since 1914, and are classed under the following head: "Substances, preparations, and mixtures, odoriferous or aromatic, used in the preparation of perfumes or cosmetics, n. s. p. f., not containing alcohol."

From October 3, 1913, to June 30, 1914, the imports so classified were valued at $280,461. In the fiscal year 1915 this increased to $552,579, and in 1916 reached the maximum of $637,839. For the period 1917–1919 the average annual import was about $500,000. The quantity of the imports was shown for the first time in 1919 and amounted to 34,451 pounds.

The average revenue yielded by this classification has been in the neighborhood of $100,000 per annum.

Detailed statistics for all of the materials included under the various heads were shown for the first time by Dr. E. R. Pickrell in the census of chemicals and allied products imported during the fiscal year 1914.[1] This census shows that synthetic coal-tar perfumes imported in 1914 amounted to 68,374 pounds valued at $65,404,

[1] Department of Commerce, Miscellaneous Series No. 82.

while the imports of the coal-tar flavors coumarin and vanillin made up an additional 46,119 pounds valued at $112,406. Under the caption "Substances, preparations, and mixtures, odoriferous or aromatic, used in the preparation of perfumes and cosmetics (not containing alcohol"), Dr. Pickrell's report shows that 455,704 pounds, valued at $416,231, were imported. About 165 different articles are included, many of which appear in several grades or varieties. If civet, musk, and enfleurage greases (which are not discussed in this report) are subtracted from the above figures, there remain 411,225 pounds valued at $322,821. If this is added to the statistics for the imports of coal-tar perfumes and flavors, we obtain a total of 525,717 pounds valued at $500,631, which may be taken as a fairly accurate statement of the total pre-war imports of synthetic aromatic chemicals and mixtures and preparations used in the manufacture of perfumes and cosmetics. (See pp. 97 and 98 for the import statistics of the principal items shown in the Pickrell compilations.)

Prices.—Trade journals, such as the Oil, Paint, and Drug Reporter, ordinarily publish price quotations for a number of the so-called artificial essential oils, such as bitter almonds, bergamot, mustard, neroli, niobe, rose, sassafras, and wintergreen. Many of the synthetic aromatic chemicals and preparations do not appear in trade quotations. Drug and Chemicals Markets, since June, 1919, however, has published market prices for a comprehensive list of aromatic chemicals. These prices by quarters are shown on page 95.

The synthetic aromatic chemicals are, as a rule, complex substances which are difficult to make. They must be of highest purity and quality and they have a small market. For these reasons they are very expensive and in general range in price from about $1 per pound, as in the case of safrol, methyl salicylate, and benzaldehyde (U. S. P.), to $40 to $50 per pound, as in the case of cinnamyl alcohol, musk ketone, and phenyl acetaldehyde. Sales of other compounds at $100 a pound are not uncommon. The artificial oils which are competitive with those of natural origin usually sell for considerably less than the natural products, although in certain cases, where the resemblance is close, there is only a slight difference in price. The synthetic flower oils, such as those possessing the odors of the carnation, jasmine, lilac, lily-of-the-valley, rose, and tuberose, are in general more expensive products and $50 per pound may be taken as an average price. Certain products of this character, however, sell for several times that amount.

The introduction of synthetic materials successfully imitating the properties of natural products has tended to bring prices to a lower level and to some extent prevents the fluctuations common to this class of commodities. Examples of this were pointed out by Piver in 1900. His report shows the following prices per pound for vanillin and heliotropin between 1876 and 1900:

Year.	Vanillin.	Heliotropin.	Year.	Vanillin.	Heliotropin.
1876	$766.00	$331.75	1886	$76.50	.....
1879	175.00	218.85	1892	76.50	$21.90
1881	175.00	153.25	1893	76.50	13.15
1882	175.00	109.45	1897	11.85	3.95
1884	98.50	65.66	1900	8.75	2.65
1885	98.50	49 27			

During this same period coumarin fell from $22 to $4.75 per pound and aubepine from $22 to $5.65 per pound.

TARIFF HISTORY.

The provision for natural and synthetic, odoriferous substances, preparations, and mixtures used in the manufacture of perfumes and cosmetics appeared for the first time in the tariff act of 1913, and a duty of 20 per cent ad valorem was provided. Under previous tariff acts these materials were rather diversely classified.[1] The artificial essential oils were usually held dutiable under the provisions for the natural oils. (See G. A. 5535, T. D. 24905, and G. A. 5732, T. D. 25438.) Certain combinations of floral odors, such as muguet concretes, were held to be mixtures and combinations of essential oils, which provision from 1883 to 1909 was dutiable at 25 per cent ad valorem. The synthetic aromatic chemicals were usually classified as "chemical compounds * * * not specially provided for," dutiable at 25 per cent ad valorem.

Certain aromatic chemicals of coal-tar origin, such as aubepine (Abstract 21062, T. D. 29700; G. A. 1859, T. D. 13587) were held to be coal-tar preparations not colors or dyes, not medicinals, n. s. p. f., dutiable at 20 per cent ad valorem under the tariff acts of 1883 and 1890, free under the act of 1894, and dutiable at 20 per cent in 1897 and 1909. Flavors of coal-tar origin are dutiable under Title V, section 500, Group III of the act of September 8, 1916, which provides a duty of 30 per cent ad valorem for flavors of coal-tar origin. Certain other aromatic coal-tar chemicals, such as benzaldehyde and benzyl chloride, which are used as intermediates for dye manufacture, as well as in perfumery, are dutiable under Group II of the same act at 15 per cent ad valorem, plus 2½ cents per pound.

TARIFF CONSIDERATIONS.

Act of 1913, par. 49. "* * * all natural or synthetic odoriferous or aromatic substances, preparations, and mixtures used in the manufacture of, but not marketable as, perfumes or cosmetics; all the foregoing not containing alcohol and not provided for in this section * * *."

The above provision presents several tariff problems of importance. As previously noted in this report, this provision includes a large number of materials of widely different character which can, however, be divided into two separate and distinct groups, representing the products of two branches of the perfume industry.

Aromatic chemicals.—The first group consists of the definite chemical bodies known as aromatic chemicals. Should it be desired to provide separately for these two classes of perfume materials, the material in the first group might be described for tariff purposes as follows:

Odoriferous or aromatic chemical substances, uncompounded, obtained from essential oils or from natural or chemical products.

These materials are now produced on a substantial scale in the United States and during the war the bulk of our consumption was supplied by domestic production. The manufacture of the aromatic

[1] For more detailed discussion, see Court and Treasury Decisions, p. 96, infra.

chemicals of coal-tar origin forms a well-defined branch of the new dyestuff industry, since it consumes as its raw materials the same chemicals which are used for the production of intermediates, dyes, and synthetic pharmaceuticals. These perfume materials were practically the only coal-tar products not provided for as a group in the act of September 8, 1916, although this act included provisions for the closely related coal-tar flavors and for a number of individual articles used for both dye and perfume manufacture (e. g., benzaldehyde, benzyl chloride, and nitrobenzol). In the proposed amendment to the act of September 8, 1916 (H. R. 8078, popularly known as the Longworth bill), as passed by the House of Representatives September 29, 1919, these synthetic perfume materials were not included, although their incorporation in the bill had been considered in the hearings before the Ways and Means Committee. (See hearings on H. R. 8078 before the Ways and Means Committee, pp. 518–534.)

When the Longworth bill came before the Senate Finance Committee, however, another effort was made to extend its provisions in order to cover the synthetic perfume materials of coal-tar origin. (See hearings on H. R. 8078 before Senate Finance Committee, pp. 207–216 and 614, 615.) In this connection the following statement by the United States Tariff Commission, in a letter addressed to Congressman Longworth on August 5, 1919, was introduced in the hearings:

> In the preparation of the report of the Tariff Commission, dated December 12, 1918, suggesting a revision of title 5 of the act of September 8, 1916, perfumery materials were purposely left out because Congress had apparently clearly expressed an intent to leave them dutiable under the tariff act of 1913. Perfume materials of coal-tar origin are, however, so closely allied to drugs and flavors of similar origin that they might logically be included with them. There are materials, such as methyl salicylate, which may be used as drugs, flavors, or perfumes. Benzyl benzoate and benzyl acetate are worthy of special mention by name because in addition to their use as drugs and perfumes they were found during the war to be useful as a solvent for the varnish used on airplane wings, and large amounts were made for this purpose. The material used for this purpose does not require to be of the high quality necessary for use in medicine or perfumery, and, therefore, it is suggested that these two substances be mentioned by name in order to forestall a claim by an importer that the materials are not perfume materials, but solvents for airplane varnish.
>
> If Congress desires to include perfume materials in Group III, the following amendments to H. R. 8078 will accomplish this purpose:
>
> Insert, on page 5, line 7, of H. R. 8078, after the word "flavors," the following: "* * * benzyl acetate, benzyl benzoate, synthetic odoriferous or aromatic substances, preparations, and mixtures, used in the manufacture of, but not marketable as, perfumes and cosmetics and not containing alcohol."
>
> Add to the repealing clause, page 8, line 8, after the figure "46," the figure "49."
>
> On page 5, line 2, after the word "flavors," insert the words "synthetic materials for perfumes and cosmetics."

In the bill as reported by the Finance Committee, however, the proposed amendment to cover synthetic perfume materials was not incorporated.

Mixtures and preparations.—The second group includes the mixtures and combinations of aromatic chemicals, with or without the addition of essential oils and other natural floral products. These compounded semifinished materials for tariff purposes might be described as follows:

> All compounded preparations, mixtures, and combinations of essential and distilled oils, odoriferous or aromatic substances, and natural floral products, used in the manufacture of, but not marketable as, perfumes or cosmetics, and not containing alcohol.

This provision would include all of the so-called "artificial flower oils," as well as compounded preparations obtained by combining and blending a number of odors of either natural or chemical origin. These preparations, as previously noted in this report, are more highly manufactured than are the straight aromatic chemicals. The compounding and blending requires considerable technical skill and experience, and in some cases is carried almost to the stage of the finished perfumes. The composition of these mixtures is known only to their manufacturers, who market them under trade names, which usually offer little or no clue as to their character. Many of these preparations may represent a compounding of a large number of constituents and by a simple addition of alcohol may become marketable as finished perfumes. By importing these semimanufactured preparations and completing the compounding in this country there is thus a possible means of evading the higher duties imposed on finished perfumes and toilet waters.

General Information for Individual Articles.

AROMATIC CHEMICALS.

Of coal-tar origin (those marked with an asterisk are discussed in detail):

*Acetophenone or hypnone.
Amyl cinnamate.
Amyl phenyl acetate.
Amyl salicylate.
*Artificial musk.
Musk xyline crystals.
Musk ketone.
Musk, ambrette.
*Aubepine or anisic aldehyde (methyl paraoxybenzaldehyde).
*Benzaldehyde.
*Benzyl alcohol.
*Benzyl acetate.
Benzyl butyrate.
*Benzyl chloride.
Benzyl cinnamate.
*Benzyl benzoate.
Benzyl formate.
Benzyl phenyl acetate.
Benzyl propionate.
Benzyl isovalerate.
Benzyline acetone.
Bromelia or neroline (ethyl ether of beta-naphthol.)
*Bromstyrol.
*Cinnamic aldehyde.
Cinnamene chloride.
*Coumarin.
Diethyl phthalate.
Dimethyl anthranilate.
*Diphenyl oxide or artificial geranium.
Diphenyl methane.
Ethyl anthranilate.
Ethyl benzoate.
Ethyl cinnamate.
Ethyl phenyl acetate.
Hydratropic aldehyde.
Indol.
Isobutyl anthranilate.
Isobutyl benzoate.
Isobutyl cinnamate.
Melilot (paramethyl acetophenone).
Methyl acetophenone.
*Methyl anthranilate.
Methyl benzoate.
Methyl cinnamate.
Methyl phenyl acetate.
Methyl phthalol.
*Methyl salicylate.
Methyl para cresol.
*Musk, see Artificial musk.
*Nerolin (ethyl ether of beta-naphthol).
Orchidee or sanforie (iso amyl salicylate).
Orchidone (iso-butyl salicylate).
Phenetol (ethyl phenyl ether).
*Phenyl acetaldehyde.
Phenyl acetic acid.
*Phenyl ethyl acetate.
*Phenyl ethyl alcohol.
Phenyl ethyl benzoate.
Phenyl ethyl formate.
Phenyl ethyl phenyl acetate.
Phenyl ethyl propionate.
Phenyl propyl alcohol.
Phenyl propyl acetate.
Propyl phenyl acetate.
*Salicylic aldehyde.
Skatol.
Vanillin (when made from synthetic guaicol).
*Yara Yara (methyl ether of beta-naphthol).

Of noncoal-tar origin (those marked with an asterisk are later discussed in detail):

1. From essential oils of other natural sources:
   - *Anethol.
   - *Anisic aldehyde (from anethol).
   - Borneol.
   - Bornyl acetate.
   - Carvol.
   - *Citral.
   - *Citronellal.
   - *Citronellol.
   - Eucalyptol.
   - *Eugenol.
   - *Geraniol.
   - Geranyl acetate.
   - Geranyl butyrate.
   - Geranyl formate.
   - *Heliotropin.
   - *Ionone.
   - Iralol—alpha and beta.
   - Irone.
   - Isoborneol.
   - Isoeugenol.
   - *Linalool.
   - Linalyl acetate.
   - Linalyl formate.
   - Linalyl valerate.
   - *Menthol.
   - Methyl iralol.
   - Oenanthic ether.
   - *Rhodinol.
1. From essential oils of other natural sources—Continued.
   - *Safrol.
   - Santalol.
   - *Terpineol.
   - Terpinyl acetate.
   - *Vanillin (when made from eugenol).
2. From chemical sources:
   - *Amyl acetate.
   - Amyl valerate.
   - Decyl aldehyde.
   - Decyl alcohol.
   - Ethyl acetate.
   - Ethyl butyrate.
   - Ethyl citrate.
   - Ethyl formate.
   - Ethyl oxalate.
   - Ethyl propionate.
   - Ethyl valerate.
   - Heptyl alcohol.
   - Isoamyl acetate.
   - Isobutyl acetate.
   - Isobutyl valerate.
   - Nonyl alcohol.
   - Nonyl aldehyde.
   - Octyl alcohol.
   - Octyl aldehyde.
   - Propionic acid.
   - Valeric acid.

DETAILED INFORMATION CONCERNING THE PRINCIPAL AROMATIC CHEMICALS.

Of coal-tar origin.—1. *Acetophenone*, or hypnone, is chemically known as a ketone and corresponds to the formula $C_6H_5CO\,CH_3$. It is prepared synthetically by treating benzol with acetyl chloride. It has a strong odor, somewhat resembling that of acacia flowers, and is used principally in perfuming soaps. It is now produced on a commercial scale in the United States. Imports during the fiscal year 1914 amounted to 236 pounds, valued at $469, 80 per cent coming from Germany.

2. *Artificial musk* of commerce is chiefly trinitro-iso-butyl-xylene ($C_{12}H_{15}(NO_2)_3$), although similar and related products, such as trinitro-iso-butyl-toluene and trinitro-butyl-tolyl-azoimide, are also marketed under the name of "artificial musk." The original musk, discovered by Bauer in 1888, was the toluene derivative and was prepared by treating toluene with isobutyl chloride by means of aluminum chloride (a process well known to chemists as the "Friedel and Crafts reaction"). The isobutyl toluene thus prepared is carefully purified and then treated with a mixture of sulphuric and nitric acids. The purified artificial musk consists of small, yellowish, needle-shaped crystals having the peculiar odor of musk. It is utilized largely in the manufacture of scented toilet soaps and, to a lesser extent, in perfumes. Musk ketone is a derivative of artificial musk which possesses a slightly different odor. Ambrette musk and similar derivatives are products of more complicated syntheses from

meta xylene and meta cresol, and are valued for their particular odoriferous properties and their greater solubility.

The United States is one of the largest consumers of artificial musk, but apparently its manufacture has not as yet been established on a large scale in this country. This slow development has been caused principally by the difficulty in securing such raw materials as meta xylol and meta cresol of the desired purity. The demand for these materials is small and their purification would require the installation of certain special equipment.

The imports of synthetic musk in 1914 amounted to 9,686 pounds and were valued at $14,901. Switzerland, France, and Germany were the principal sources of supply.

Synthetic musk was quoted at $1.75 per pound in August, 1914; at $4 in January, 1915; $8.50 in January, 1916; $11.50 in January, 1917. The price rose to $30 in January, 1919, but during the year dropped off about 50 per cent, and in January, 1920, synthetic musk was quoted at $13 to $15 per pound. This price has obtained during the first three quarters of 1920.

3. *Aubepine*, or anisic aldehyde, is paramethoxybenzaldehyde ($C_6H_4(OCH_3)CHO$). It is the basis for perfumes of the hawthorne and mayblossom types. It is prepared in either of two ways: (1) By the methylation of paraoxybenzaldehyde which is obtained as a by-product in the manufacture of salicylic aldehyde (ortho oxybenzaldehyde), or (2) by the oxidation with (chromic acid) of anethol, an alcohol obtained from anise oil. Aubepine was produced in the United States during 1918 and 1919, but the production statistics can not be published without revealing confidential information. The imports during the fiscal year 1914 were 4,140 pounds, valued at $5,253, and came principally from Germany.

4. *Benzaldehyde*, or artificial oil of bitter almonds, is a colorless volatile oil corresponding to the formula C_6H_5CHO. It has the fragrant odor characteristic of almonds. Benzaldehyde is usually prepared from toluol by chlorinating to form benzal chloride which is heated under pressure with milk of lime and calcium carbonate. It is used as an intermediate in some dyes, in organic synthesis, in flavoring compounds, in perfumery, and to a limited extent in medicine. There are three grades of benzaldehyde, viz., technical, f. f. c. (free from chlorine), and U. S. P. Only the latter two grades are suitable for use in perfumes and flavors.

In the Tariff Commission's statistics for the domestic production of benzaldehyde no effort has been made to differentiate between the various grades. In 1917 there were seven manufacturers of benzaldehyde and their production was 132,336 pounds valued at $2.72 per pound. In 1918, 11 producers reported an output of 360,591 pounds valued at $2.40 per pound. The 1919 census of production listed 13 manufacturers with a combined production of 518,634 pounds valued at $0.78 per pound. The lower price in 1919 was largely due to the release of toluol from military requirements. The imports of benzaldehyde in 1914 consisted of only 5,640 pounds of the technical product valued at 25 cents per pound and 876 pounds of the pure product valued at 43 cents per pound. The small imports as compared with the present domestic production is explained by the fact that prior to 1914 our consumption was very small. With the establishment of the dye industry on a large scale, however, large

quantities of benzaldehyde were required for the manufacture of certain important colors, such as the malachite and brilliant greens. Benzaldehyde was mentioned specifically in Group II of the act of 1916, and has been dutiable since that time at 15 per cent ad valorem plus 2½ cents per pound.

5. *Benzyl alcohol* is a colorless liquid with a faint aromatic odor and is used in perfume mixtures as a fixative and also as an intermediate material for other aromatic chemicals. It is prepared by chlorinating toluol to benzylchloride and replacing the chlorine with an hydroxyl group. Its chemical formula is $C_6H_5CH_2OH$.

The domestic production of technical benzyl alcohol has been reported by the Tariff Commission to have been as follows:

Year.	Number of manufacturers.	Production.	Value.	Value per pound.
		Pounds.		
1917	4	10,403	$47,383	$4.55
1918	6	13,950	87,138	6.25
1919	7	15,678	33,770	2.15

The imports in 1914 were 3,020 pounds valued at $1,733 and came chiefly from Germany.

6. *Benzyl acetate* ($C_6H_5CH_2C_2H_3O_2$) is perhaps the most important of the benzyl esters used as such in perfumery. It is a very important constituent of natural oil of jasmine and is found in ylang-ylang and other natural flower oils. It has a fruity odor and is used in combination with other materials in soap manufacture. The pure ester is most largely used in artificial jasmine products.

The production of benzyl acetate in this country, shown for the first time in the Tariff Commission's census for 1918, amounted to 30,193 pounds valued at $101,284. There were seven producers. In 1919 the total production was 17,049 pounds valued at $39,137. The decrease in output during 1919 is explained by the fact that during 1918 benzyl acetate (and benzyl benzoate) were largely used as high-boiling solvents for the waterproofing used on airplane wings.

Imports in 1914 were reported to be 12,197 pounds valued at $5,893, of which Germany furnished 83.1 per cent.

7. *Benzyl chloride* ($C_6H_5CH_2Cl$), like benzaldehyde, is not primarily a synthetic perfume material but is important in that it is the intermediate material from which the important benzyl esters are produced. It is a colorless liquid with an aromatic odor and is prepared by toluene with chlorine. In addition to the technical grade a pure product is sold for medicinal use.

The production as reported by the Tariff Commission includes all grades of benzyl chloride. The output has been as follows:

Year.	Number of manufacturers.	Output.	Value.	Value per pound.
		Pounds.		
1917	11	136,179	$163,998	$1.20
1918	11	690,930	463,071	.66
1919	8	720,953	166,182	.23

The imports of benzyl chloride in 1914 amounted to 4,261 pounds, valued at $12,074, all of which came from Germany. During the calendar year 1919, 1,000 pounds of benzyl chloride, valued at $430, were imported.

Benzyl chloride was mentioned specifically in the act of September 8, 1916, and a duty of 15 per cent ad valorem plus 2½ cents per pound was provided.

8. *Benzyl benzoate* ($C_6H_5CH_2COOC_6H_5$), although not found in nature, is used largely in perfumery as a fixative and as a solvent for other constituents. It is a colorless, oily liquid with but a very faintly aromatic odor. Benzyl benzoate has recently been used in medicine with considerable success as a nonnarcotic antispasmodic. During the war it was found that benzyl benzoate and benzylacetate were well adapted for use as solvents for the "dope" used for fireproofing and waterproofing the wings of airplanes.

Production of benzyl benzoate was shown for the first time in the Tariff Commission census for 1918, which showed that five firms produced a total of 62,318 pounds, valued at $5.46 per pound. In 1919 it was produced in a much smaller quantity by three firms, but the output can not be published without revealing confidential information.

Imports of benzyl benzoate during the fiscal year 1914 amounted to 10,102 pounds, valued at $5,291, of which over 30 per cent came from Germany.

9. *Bromstyrol*, which is the bromine derivative of the hydrocarbon styrene (phenyl-ethylene), corresponds to the chemical formula $C_6H_5-CH=CHBr$. It is a heavy, pale amber-colored oil with a sweet odor, resembling that of the jacinth. It is used extensively in perfuming soap and with other products in compounding perfumes. Styrene, or styrol, occurs naturally in styrax, the oriental sweet gum from *Liquid ambar orientalis*. It can, however, be prepared synthetically from cinnamic acid.

Bromstyrol has been produced in the United States since 1917 by three firms, but statistics can not be published without revealing confidential information.

The imports of bromstyrol in 1914 amounted to 165 pounds, valued at $610, 83 per cent of which came from France.

10. *Cinnamic aldehyde* ($C_6H_5-CH=COH$) is the odorous principle of oil of cassia (Chinese cinnamon oil), making up at least 80 per cent of this product. It may be obtained by distillation from cassia or cinnamon oils or may be prepared synthetically by the condensation of benzaldehyde with acetaldehyde. The synthetic product is a pale lemon-colored liquid of great purity. Cinnamic aldehyde is used principally in flavoring extracts and to some extent in the manufacture of toilet soaps and cosmetics, such as tooth pastes.

Statistics are not available for the domestic production. Imports classified as cinnamic aldehyde in 1914 amounted to 6,066 pounds valued at $4,934. It is believed that considerably larger quantities were imported and classified as artificial cassia or cinnamon oils.

11. *Coumarin* ($C_9H_6O_2$) is a white crystalline solid occurring naturally in tonka beans, dear-tongue leaves, and other plants. Chemically, coumarin is the d-lactone of coumaric acid. It was first prepared synthetically by Sir W. H. Perkin in 1867 by heating salicylic aldehyde with acetic anhydride and sodium acetate—the method still

in use. The synthetic product has practically driven the natural coumarin from the market. Its chief commercial use is as a flavor, but it is used to some extent in perfumery as a fixative for other odors.

The Tariff Commission census of coal-tar chemicals has never been able to publish the figures for the ouput of coumarin, although production has been reported on a large and increasing scale in 1917, 1918, and 1919. Imports of coumarin during 1914 amounted to 43,714 pounds valued at $104,852.

The act of September 8, 1916, provided a duty of 30 per cent ad valorem on flavors of coal-tar origin. There has been considerable litigation as to whether or not coumarin was dutiable under (1) the provision for coal-tar flavors, or (2) under Group II of the act of 1916 at 15 per cent, as a coal-tar intermediate for the manufacture of flavors, or (3) under the provision in paragraph 49 of the act of 1913 for materials used in the manufacture of perfumes. The Court of Customs Appeals has recently reversed a decision of a lower court, and has held that coumarin is more accurately described by the provision in paragraph 49 and, therefore, dutiable at 20 per cent ad valorem.

12. *Diphenyl oxide* (C_6H_5–O–C_6H_5), or artificial geranium, is a white crystalline material obtained by the oxidation of diphenyl by means of chromic acid. It possesses the odor of geranium leaves and is an important synthetic base for producing different geranium preparations.

Diphenyl oxide has been produced in the United States since the outbreak of the war but figures for its production can not be published without revealing the operations of individual producers.

The imports into the United States in 1914 amounted to 5,982 pounds valued at $5,944. The price in the United States during 1920 has been about $1.50 to $2 per pound.

13. *Methyl anthranilate* (C_6H_4–NH_2–CO_2CH_3), or artificial neroli, is a white crystalline material which occurs naturally in jasmine, neroli, and tuberose oils. It has a penetrating orange-blossom odor and is one of the most important synthetic perfume materials. It is also used to some extent in flavoring. One peculiar property of methyl anthranilate is caused by the fact that when brought in contact with certain other substances such as aldehydes and ketones, it combines chemically with them to form colored products. Thus, its use is limited to some extent to products in which this color reaction is not detrimental. If, instead of methyl anthranilate, the perfumer uses the methyl ester of methyl anthranilic acid (methyl methyl or dimethyl anthranilate) the formation of a color is avoided, but at the expense of the odor. Methyl anthranilate is prepared by heating anthranilic acid with methyl alcohol in the presence of hydrochloric acid.

Domestic production of methyl anthranilate was reported by the Tariff Commission 1918, but statistics could not be published without revealing the operations of the single producer. In 1919 three manufacturers reported an output of 695 pounds valued at $11.90 per pound.

In 1914 the imports amounted to 779 pounds valued at $1,537.

14. *Methyl salicylate* ($HOC_6H_4CO_2CH_3$), or artificial oil of wintergreen, is a colorless oily liquid with a strong odor of wintergreen. It is largely used as a substitute for oil of wintergreen and in fact

has to a large extent replaced the natural product as a flavoring material for extracts, confectionery, and liniments and other medicine. Methyl salicylate is official in the United States Pharmacopœia (IX) although when used as a medicine the label must indicate whether it has been produced synthetically or is obtained by distillation from the natural plants. The synthetic product is prepared by heating methyl alcohol and salicylic acid in the presence of sulphuric acid.

Methyl salicylate was produced by four firms in 1917 and by the same number in 1918, but in neither year could the figures be published without revealing individual operations. In 1919 the output amounted to 879,820 pounds, valued at $332,123. Production of natural oil of wintergreen was quoted at about 25 cents per pound in August, 1914, and by January 1, 1915, the price had risen to 55 cents. The rise continued throughout 1915 and 1916, and at the beginning of 1917 had reached $1.20 per pound. Since that time the price has fallen off, and during 1919 and 1920 methyl salicylate has been quoted in the neighborhood of 75 cents.

Imports of methyl salicylate have been small, even before the war. The 1914 import amounted to 12,147 pounds, valued at $2,513, of which over 90 per cent came from France. For tariff purposes it has been classified under the same provision as natural oil of wintergreen, dutiable at 20 per cent ad valorem.

15. *Nerolin*, the ethyl ether of beta-naphthol ($C_{10}H_7OC_2H_5$), is a white crystalline solid with a strong aromatic or fruity odor. It is used extensively in perfuming cheaper grades of soap and also to some extent in perfumes and cosmetics. It is prepared by heating beta-naphthol with ethyl iodide and alkali.

Domestic production of nerolin was reported to the Tariff Commission for the first time in 1919, but the figures can not be published without revealing individual operations. Imports in 1914 amounted to but 352 pounds, valued at $613.

Yara yara ($C_{10}H_7CO_2CH_3$), the methyl ether of beta-naphthol, is closely related to nerolin, differing from it only in that methyl instead of ethyl alcohol is used in its preparation. Its odor is somewhat more powerful and persistent, but in general is used for the same purposes as is nerolin. Production has been reported in 1919 by a single domestic firm. The imports, which have been small, amounted in 1914 to 374 pounds, valued at $435.

16. *Phenyl acetaldehyde* ($C_6H_5CH_2CHO$) is a colorless liquid with a strong hyacinth odor. In conjunction with bromstyrol, phenyl acetaldehyde forms the basis of most of the commercial jacinth or hyacinth preparations. It is prepared by the action of sodium hydroxide on phenyl-alpha-chloro-acetic acid or by heating phenyl lactic acid with dilute sulphuric acid.

Production of phenyl acetaldehyde was reported to the Tariff Commission by one firm in 1919. The imports in 1914 amounted to 358 pounds, valued at $2,169, and 70 per cent came from Switzerland.

17. *Phenyl ethyl acetate* ($C_6H_5C_2H_4(C_2H_3O_2)$ is found in nature in oil of roses and in conjunction with other materials is used in making synthetic rose preparations. It is a colorless oil with a decidedly fruity odor. It is prepared synthetically from phenyl ethyl alcohol.

Production was reported to the Tariff Commission in 1919 by two firms, but the figures can not be published. The Pickrell census of imports in 1914 did not show any importation of phenyl ethyl acetate.

18. *Phenyl ethyl alcohol* ($C_6H_5CH_2CH_2OH$) forms nearly 60 per cent of the oil extracted from rose blossoms and accordingly is a very valuable material for the preparation of artificial perfumes of the rose type. The pure product is a colorless heavy oil with a characteristic roselike odor. It is extensively used either as such or in the form of its esters (acetate, formate, benzoate, etc.) for compounding many floral odors.

Phenyl ethyl alcohol was reported to the Tariff Commission in 1919, but the output could not be published without revealing confidential information. The imports in 1914 were reported to be 1,198 pounds, valued at $6,404. In addition considerable quantities were probably classified as synthetic rose preparations.

19. *Salicylic aldehyde,* sometimes known as salicylous acid, is chemically ortho-oxy-benzaldehyde (C_6H_4OHCHO). It can be prepared by oxidation of salicin, a glucoside from the bark of *salix,* but is usually prepared synthetically by treating phenol with chloroform in the presence of sodium hydroxide. It is a yellow oil with an aromatic odor and is used in perfumery, where it is known as "reine des pres" (meadow sweet). It can be used for the synthesis of coumarin.

Salicylic aldehyde was reported for the first time in the Tariff Commission's census of production for 1919 and by a single producer. The imports in 1914 consisted of but 23 pounds—14 pounds invoiced as "synthetic" and valued at $1.50 per pound, and 9 pounds invoiced as "genuine" and valued at $13.75 per pound.

SYNTHETIC AROMATIC CHEMICALS OF NONCOAL-TAR ORIGIN.

20. *Anethol* is a camphorlike body, which makes up the larger part of the oil obtained from anise seed. It is chemically para-meth-oxy-propenyl-benzene and is represented by the formula $-C_3H_5-C_6H_4(OCH_3)$. Anethol is obtained from anise and fennel oils, usually by crystallization, although it can be obtained by distillation. The pure product is a solid at ordinary temperature (m. p. 22.5° C.) and crystallizes in snow-white leaflets. It has a strong aniselike odor and an intensely sweet taste.

Anethol is of principal importance in that it serves as the basis for the manufacture of anisic aldehyde, which is sold in commerce as *aubepine.* This so-called aubepine, which may also be prepared from coal tar, is the principal constituent in all artificial hawthorne or may-blossom perfumes.

The domestic production of anethol has not been reported in official publications. The imports of anise-seed oil have averaged about 120,000 pounds per year, but it is not known what proportion of this quantity is used for the production of anethol. The imports of anethol into the United States were shown in 1914 and amounted to only 495 pounds, valued at $890, all of which came from Germany.

21. *Anisic aldehyde* is discussed under the aromatic chemicals of coal-tar origin, although it is usually prepared from anethol by oxidation with chromic acid.

22. *Citral* is an aliphatic aldehyde ($C_{10}H_{16}O$), which is one of the active principles of lemon oil and also a major constituent of oil of lemon grass. It is largely responsible for the flavor of lemon oil, and is therefore of some value as a concentrated lemon flavor. From the point of view of the perfumer it is of most interest as a raw ma-

terial which can be converted into valuable perfumes by synthetic processes. Of most importance, perhaps, is the derivative, *ionone*, which is the basis for all synthetic violet perfumes.

Statistics for the domestic production of citral are not available, although it is known that considerable quantities of lemon-grass oil are imported for their citral content.

The imports of citral in 1914 were 1,771 pounds, valued at $3,867, of which 76 per cent came from Germany.

For tariff purposes citral has been classified as oil of lemon. (In re Fritzsche, 56 Fed., 819, affirming G. A. 999 (T. D. 12137).)

23. *Citronellal* is an aldehyde closely related to citral and is one of the principal constituents of citronella oil. Citronella corresponds to the formula $C_{16}H_{18}O$, and is largely used as a raw material for other synthetic perfume materials. Citronella oil is imported into the United States in considerable quantity for the production of citronellol and the terpene alcohol *geraniol* (see later).

The imports of citronellol in 1914 amounted to but 464 pounds, valued at $2,465.

24. *Citronellol* is a terpene alcohol corresponding to the formula $C_{10}H_{20}O$, which is found associated with geraniol in the oils of rose, geranium, palmarosa, and citronella. Citronellol does not exist by itself in any of the flower oils, and since its separation from geraniol can be accomplished only by destroying a large proportion of this valuable material, it is often sold as a mixture of geraniol, citronellol, and other related alcohols present in oil of roses. This mixture is known in the trade as rhodinol (see later). Citronellol can be produced synthetically from citronellal. The synthetic product is a colorless liquid with a rose-like odor, although used largely in compounding sweet-pea and orange-flower preparations.

The domestic production of citronellol is not known. In 1914 the imports of citronellol were reported to be 1,526 pounds, valued at $4,318. France and Germany supplied the bulk of this quantity. Imports of rhodinol, which were considerably smaller, are discussed in connection with that article.

25. *Eugenol* ($C_3H_5C_6H_3(OH)OCH_3$) is a phenol which makes up about 90 per cent of oil of cloves. It is extracted by agitating the oil with a soda solution, followed by treatment with an acid. It is purified by distillation in a stream of carbon dioxide gas. Eugenol when treated with an alcoholic potash is changed to its isomer isoeugenol, and this product is the basis for the manufacture of vanillin, the most important of the flavoring principles. This is the principal use for eugenol, and will be discussed later in connection with vanillin.

The production of eugenol is carried on to a large extent in this country. Statistics showing the output of eugenol have not been published, but in 1914 the Census of Manufactures reported that the domestic production of vanillin amounted to 120,619 pounds, valued at $525,219.

Imports of eugenol, even before the war, were small and in 1914 totaled only 490 pounds, valued at $991.

26. *Geraniol* is an alcohol corresponding to the formula $C_{10}H_{18}O$, which, as such or in the form of its esters, constitutes a large proportion of palma rosa or Indian geranium oil. It is isolated from this oil and finds considerable application in synthetic geranium and rose preparations. Geraniol has been found to be one of the principal

constituents of oil of rose, which accounts for its extensive use in artificial rose oils. It is also one of the alcohols contained in the mixture known as rhodinol. (See p. 92.) In addition to palma rosa oil, geraniol occurs in citronella and African geranium oils. It can also be prepared chemically from citronellal and from linalool, an alcohol from oil of linalol.

Of the esters of geraniol used in perfumery, the following are the most important: Geraniol acetate, geraniol formate, and geraniol butyrate.

Domestic production of geraniol has not been reported. Imports in 1914 amounted to 2,727 pounds, valued at $6,338. Imports of geraniol acetate amounted to 198 pounds, valued at $634.

27. *Heliotropin*, or piperonylic aldehyde, is a white crystalline material whose chemical composition is represented by the formula $CH_2O_2C_6H_3CHO$. It possesses the odor of heliotrope and is probably the natural constituent responsible for the odor of that flower. Heliotropin is obtained, however, from an entirely different source. The substance *safrol*, which forms 80 per cent of the oil of sassafras and is also present in camphor oil (from which the bulk of the safrol is obtained), is treated with a solution of a potassium salt to form iso-safrol and this product is oxidized with chromic acid or with ozone to form heliotropin.

Heliotropin crystals are used in perfumery as a synthetic base for heliotrope odor, and also as a constituent in lilac, lily, violet, and other preparations. Some heliotropin is also used in flavoring confectionery.

The domestic production of heliotropin is not known although the manufacture is carried on on a substantial scale in this country.

The imports of heliotropin crystals in 1914 amounted to 10,219 pounds, valued at $8,715. The domestic product during 1919 and 1920 has been quoted at $3.50 to $5 per pound.

28. *Ionone* ($C_{13}H_2O$) and its derivatives form the basis for the manufacture of practically all artificial violet perfumes and cosmetic preparations. The odor of iris (or orris) root, which is similar to that of the violet, has been found to be due to the ketone irone, which possesses the same formula and is therefore isomeric with ionone. As pointed out in the discussion of citral, ionone is prepared from that product by condensing it with acetone to form the substance known as pseudo-ionone. By treatment with acids this material is converted into ionone. Ionone exists in two isomeric forms (an *alpha* and *beta* ionone), each of which has a slightly different odor. Of the several derivatives of ionone, the most important, perhaps, are the methyl ionones known as a-iralol and b-iralol. The violet ketones and their derivatives are marketed under a number of trade names.

Considerable ionone is manufactured in this country, but the total domestic production has not been published. The census of imports for 1914 reported only 190 pounds of ionone, valued at $1,178. In addition, however, the following quantities of artificial violet preparations were also imported:

Name.	Quantity.	Value.
	Pounds.	
Alefol violet	25	$276
Atonone (synthetic violet)	30	147
Do	90	681
Cynthial (artificial violet)	49	431
Folione, green violet	28	1,049
Ionirone (artificial violet)	63	218
Iraldiol	76	875
Iralia (orris violet)	30	490
Irenia	20	318
Irisolette	915	4,919
Irisolette, for soap	800	2,466
Irisone	1,650	6,571
Do	391	2,023
Violet, crystal	1,962	11,426
Violet oil, synthetic	1,165	5,586
Violette for soap	15,598	2,816
Total	22,827	40,292

29. *Linalool* ($C_{10}H_{17}OH$) is an alcohol which constitutes a large proportion of the oils of linaloe and rosemary. It also exists either in a free state or in combination, in bergamot, lavender, neroli, petit-grain, ylang ylang, and other oils. The pure product is a colorless liquid with an odor similar to bergamot oil and French lavender. It is produced on a commercial scale in the United States from linaloe oil, of which Mexico is the principal source.

Imports of linaloe oil in 1914 amounted to 4,067 pounds valued at $10,443. In addition, there were 104 pounds of terpeneless oil valued at $488. Imports of linalool during the same year amounted to 406 pounds valued at $1,406. Linalyl acetate, the principal ester of linalool, was imported in the following amount: Four hundred and seventy-one pounds valued at $2,206.

30. *Menthol* is a camphor-like material obtained from oil of peppermint. Although by nature and use menthol belongs to the class of aromatic chemicals, it is elsewhere mentioned specifically in the tariff law and is given detailed discussion in that connection.

31. *Rhodinol* of commerce, as pointed out under the discussion of citronellol (see p. 90), is a mixture of geraniol, citronellol, and other related alcohols present in oil of rose. Chemically rhodinol is laevo-citronellol ($C_{10}H_{20}O$), but this product is not the ordinary article of commerce. Statistics for domestic production of rhodinol are not available, although it is believed that considerable quantities are produced for the preparation of synthetic rose perfumes. The imports in 1913 consisted of 181 pounds valued at $1,493. In addition there were received 303 pounds of "Reunia," which is also a mixture of geraniol and citronellol. Considerably larger quantities of rhodinol were probably received in the form of the various synthetic or artificial rose preparations.

32. *Safrol*, previously referred to under heliotropin, is chemically represented by the formula $C_3H_5C_6H_3O_2CH_3$. It is a colorless or pale yellow liquid oil possessing the strong odor of oil of sassafras of which it is the odorous principle. Safrol is also present in camphor oil, from which the bulk of the commercial article is obtained. For the preparation of safrol, camphor oil—which is incorrectly known as "artificial sassafras oil"—is cooled to a low temperature, whereupon the safrol separates out in the form of crystals. It is carefully purified by fractional distillation. Safrol has been quoted during 1920

at about 80 cents per pound. The imports in 1914 amounted to 161,194 pounds valued at $35,031, all of which came from Germany.

33. *Terpineol* ($C_{10}H_{17}OH$) is a terpene alcohol obtained from terpine hydrate which, in turn, is derived from oil of turpentine. Terpineol is a colorless liquid with a lilac odor and is largely used as a basis for perfumes of the lilac and lily-of-the-valley types. It is also of some value as a soap perfume. The principal terpineol ester used in perfumery is terpinyl acetate ($C_{10}H_{17}CO_2CH_3$).

Terpineol is produced on a large scale in the United States, but statistics of its production are not available. Imports of terpineol in 1914 amounted to 141,745 pounds, valued at $32,962, of which over 95 per cent came from Germany. Imports of terpinyl acetate during the same year amounted to 19,473 pounds, valued at $10,412.

34. *Vanillin* ($C_6H_3(OH)(OCH_3)CHO$), chemically the methyl ether of protocatechuic aldehyde, is the most important flavoring principle of vanilla beans. It is prepared synthetically by the oxidation of eugenol (see p. 90), which is a phenol obtained from oil of cloves, or it may be prepared from guaiacol, a coal-tar product. Vanillin is mentioned specifically in paragraph 70 of the act of 1913 at 10 cents per ounce, and for a more complete discussion reference should be made to the Tariff Information Survey on Vanilla Beans and Vanillin. The domestic production of vanillin in 1914 was reported by the Census of Manufactures to be 120,619 pounds, valued at $585,219. The imports of vanillin have been very sporadic, ranging from 140 ounces, valued at $34, to 33,668 ounces in 1914, valued at $7,446. No imports were reported during 1916, 1917, and 1918.

35. *Amyl acetate*, sometimes known as banana oil, is the acetic ester of amyl alcohol. It occurs in two distinct grades: (1) The purified product is a colorless limpid liquid with a rather agreeable banana like odor, which is used to a considerable extent in the preparation of fruit flavors, flavoring essences, confections, and soft drinks; and (2) the grade known as a technical product, which is used in very large quantities as a solvent for pyroxylin.

Amyl acetate is prepared from pure amyl alcohol (fusel oil) by the addition of a mixture of sulphuric and acetic acids with subsequent recovery by distillation. The domestic production of amyl acetate in 1914 was 1,300,052 pounds, valued at $465,664. The production of amyl acetate in this country supplies the domestic consumption, since practically no imports of this article are shown in official publications. Of this quantity, however, only a relatively small proportion was purified sufficiently for use in perfumes and flavors. A number of other amyl esters are also used as flavoring materials in the so-called fruit ethers and esters.

Synthetic aromatic chemicals of coal-tar origin—Production in United States.

[From Census of Dyes and Coal-Tar Chemicals, 1917, 1918, and 1919. U. S. Tariff Commission.]

	1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Perfumes:			*Pounds.*		*Pounds.*	
Benzyl acetate	(1)	(1)	30,193	$101,284	17,049	$39,137
Benzyl benzoate	(1)	(1)	62,318	340,446	(1)	(1)
Methyl anthranilate	(1)	(1)	(1)	(1)	695	8,260
Methyl acetophenone	(1)	(1)	(1)	(1)	(1)	(1)
Flavors:						
Saccharin	(1)	(1)	425,600	4,489,617	547,988	1,017,091
Methyl salicylate	(1)	(1)	(1)	(1)	879,886	332,123

[1] Not shown separately.

In addition to the above, the following coal-tar aromatic chemicals were produced in the United States, but their production could not be published without revealing confidential information:

Acetophenone, amyl salicylate, aubepine (anisic aldehyde), isobutyl benzoate, benzyl butyrate, benzyl formate, bromstyrol, cinnamic alcohol, cinnamic acid, diethyl phthalate, diphenyl oxide, diphenyl methane, methyl benzoate, neroiin, ethyl benzoate, methyl phenyl acetate, methyl phthalate, salicylic aldehyde, phenyl acetic aldehyde, benzyl propionate, benzyl valeriate, phenyl ethyl acetate, phenyl ethyl alcohol, yara yara.

Flavors: Coumarin (synthetic), ethyl salicylate.

Year.	Pounds.	Value.
Coal-tar perfumes:		
1917	19,545	$125,961
1918	[1] 116,263	584,695
1919	41,419	164,302
Coal-tar flavors:		
1917	779,416	1,862,456
1918	458,256	4,925,627
1919	610,825	1,318,654

[1] Includes over 90,000 pounds of crude benzyl acetate and benzoate which were used as solvents in connection with airplane production program during 1918.

German imports and exports of synthetic perfume materials (vanillin, coumarin, anethol, heliotropin, and similar products).[1]

Year.	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1909	35,494	$75,271	919,600	$990,400
1910	39,462	82,898	941,270	1,221,500
1911	38,140	80,510	1,087,000	1,168,400
1912	40,565	85,520	1,276,000	1,220,000
1913	49,603	107,280	1,483,600	1,498,000

[1] Source: Vierteljahrshefte zur Statistik des deutschen Reichs, Berlin (1914).

French imports and exports of synthetic or artificial perfumes.

Year.	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1912	218,400	$274,830	114,490	$37,056
1913	254,346	275,800	32,426	31,847
1914	116,260	143,200	63,538	71,998
1915	97,060	222,340	48,750	48,920
1916	108,090	528,800	170,500	196,660
1917	101,470	624,800	125,738	303,980
1918	77,435	860,600	156,620	443,500

[1] Source: Documents Statistiques sur le Commerce de la France (monthly).

French imports and exports of synthetic or artificial perfumes, by countries.[1]

Country.	1913		1917	
	Quantity.	Value.	Quantity.	Value.
IMPORTS.	*Pounds.*		*Pounds.*	
Germany	178,680	.....	14,335	.....
Switzerland	48,532	.....	58,460	.....
United States	.....	.....	26,028	.....
All other	27,134	.....	2,647	.....
Total	254,346	$275,800	101,470	$624,800
EXPORTS.				
Great Britain	7,500	.....	36,178	.....
Italy	.....	.....	14,335	.....
Belgium	5,518	.....	.....	.....
British India	2,647	.....	1,324	.....
United States	3,309	.....	22,941	.....
Indo-China	1,544	.....	.....	.....
All other	11,910	.....	50,960	.....
Total	32,426	31,847	125,738	303,980

[1] Source: Tableau General du Commerce et de la Navigation (annual).

Substances, preparations, and mixtures, odoriferous or aromatic, used in the preparation of perfumes or cosmetics, n. s. p. f., not containing alcohol. (Act of 1913.)—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	20 per cent	.....	$280,461	$56,092	.....	20
1915	do	.....	552,579	110,515	.....	20
1916	do	.....	637,839	127,567	.....	20
1917	do	.....	418,774	83,754	.....	20
1918	do	.....	510,466	102,093	.....	20
1919	do	34,451	616,868	123,373	$17.90	20

Aromatic chemicals, prices per pound.

[From Drug and Chemical Markets.]

Kinds or grades.	1919		1920			
	August.	October.	January.	April.	July.	October.
Acetophenone	$8.00– $8.25	$8.00 –$10.00	$4.50– $5.75	$6.25– $6.75	$6.25– $6.50	$6.25– $6.50
Amyl salicylate	2.25– 2.50	2.25 – 2.50	1.85– 2.00	1.85– 2.00	3.00– 4.00	1.75– 2.00
Imported	.....	.....	.....	2.75– 3.00	2.75– 3.00	2.75– 3.00
Anethol	2.50– 2.75	2.50 – 2.75	2.75– 3.00	2.50– 3.00	2.50– 3.00	2.50– 3.00
Anisic aldehyde, C. P.	12.00– 14.00	7.50	7.00– 7.25	15.00	8.00	8.00– 10.00
Benzaldehyde	1.00– 1.10	2.00 – 2.50	.....	1.00– 1.25	1.00– 1.25	1.00– 1.25
Free from chlorine	.....	.....	.....	2.00	2.00	2.00
Benzyl acetate	2.00– 2.25	2.25 – 2.50	1.75– 2.00	1.75– 2.50	1.75– 2.50	2.00– 2.50
Imported	.....	5.75	.....	3.75– 4.00	4.00– 4.50	3.00– 3.25
Benzyl alcohol	2.50– 2.75	2.50 – 2.75	2.25– 2.75	1.75– 2.00	1.75– 2.00	1.75– 2.00
Imported	.....	.....	.....	3.00– 3.25	3.00– 3.25	3.00– 3.25
Benzyl benzoate	3.25– 3.50	3.25 – 3.50	3.50– 4.50	4.25	3.10– 3.26	3.75– 4.25
Imported	.....	6.00	.....	6.50	6.50	6.50
Benzyl chloride (pure)	.....	.....	.....	.....	.50	.50
Borneol	4.00– 4.25	4.00 – 4.25	3.50	3.50	3.50	3.50
Bromostyrol	12.00	12.00	11.50– 12.00	9.00– 9.50	9.00– 9.50	8.50– 9.00
Castoreum	.....	.....	.....	6.00	5.75– 6.00	.....
Cinnamic acid	7.25– 7.50	7.25 – 7.50	5.00– 6.00	5.50– 6.00	5.50– 6.50	5.50– 6.50
Cinnamic alcohol	40.00– 45.00	40.00 – 45.00	40.00– 45.00	36.00	36.00	30.00– 40.00

Aromatic chemicals, prices per pound—Continued.

Kinds or grades.	1919		1920			
	August.	October.	January.	April.	July.	October.
Cinnamic aldehyde	$5.50	$5.50	$7.25–$7.50	$5.50	$5.50	$5.50
Citral	$3.50–3.65	$4.00–4.25	4.50–4.75	$7.25–7.50	$9.00–9.25	$8.00–9.00
Citronellol	16.00–18.00	16.00–18.00	16.00–18.00	16.00	16.00	16.00
Imported		30.00	30.00	30.00	30.00–40.00	24.00–30.00
Coumarin	6.50–6.75	6.75–7.00	7.75–8.00	7.50	6.50–7.00	6.50–7.00
Ethyl benzoate				2.00	2.00	2.00
Ethyl cinnamate	8.00–10.00	8.00–10.00	6.00–8.00	6.00–8.00	7.00–8.00	7.50–8.00
Eucalyptol	1.10–1.20	1.20–1.25	1.40–1.65	1.50–1.60	1.25–1.30	1.10–1.15
Eugenol	3.75–4.00	3.75–4.00	5.50–6.50	6.00–6.50	6.00–6.50	6.00–.50
Geraniol (from citronella)	5.00–5.25	3.50–6.00	3.50–5.00	4.50–5.00	3.50–4.00	3.50–4.00
Imported					6.00	6.00
Geranyl acetate	7.25	7.25	5.75–6.50	5.75–6.00	6.00–7.00	7.00–8.00
Heliotropin	3.75–4.00	3.75–4.00	4.35–4.50	4.50–5.00	5.00–5.50	5.00–5.50
Indol, C. P.[1]	15.00	20.00	20.00	15.00	15.00	15.00
Imported		30.00	30.00	30.00	30.00	20.00
Iso-eugenol	8.50–9.00	8.50–8.75	10.00–12.00	9.25–9.75	9.50–10.00	9.50–10.00
Imported				15.00–16.00	15.00–16.00	15.00–16.00
Linalol	7.50–7.75	8.00–9.00	7.00–12.00	7.00–12.00	10.00–12.00	10.00–12.00
Linalyl acetate	9.00–13.00	9.00–13.00	13.50–15.00	13.50–15.00	16.00–18.00	16.00–18.00
Linayl benzoate			18.00	18.00	18.00	18.00
Menthol	7.65–8.00	8.75–9.00	12.50–12.75	13.00–13.25	6.00–6.50	6.00–6.25
Methyl anthranilate	16.00–18.00	15.00–17.00	14.00	11.00–11.50	10.50–11.00	9.75–10.00
Imported				17.00–20.00	13.00–14.00	13.00–14.00
Methyl cinnamate	7.25	7.25	7.00–7.25	7.50–8.00	9.00–9.50	10.00–12.00
Methyl paracresol	16.00	16.00	16.00	16.00	16.00	16.00
Methyl salicylate	.45–.50	.60	.80	.75–.80	.75–.80	.75
Mirbane, rect. drums	.19–.21	.13½–.14	.16–.17	.16–.18	.18–.19	.16–.16½
Musk ambrette	92.00–100.00	92.00–100.00	92.00–100.00	100.00–110.00	90.00–95.00	80.00–90.00
Musk ketone			45.00	50.00	50.00	45.00
Musk xylene	14.00–16.00	13.00–15.00	12.00–14.00	13.00–14.00	12.50–13.00	11.00–11.50
Phenylacetaldehyde	40.00–45.00	35.00–40.00	50.00–55.00	40.00–45.00		40.00–45.00
Phenylethylic-alcohol	40.00–42.00	35.00–42.00	38.00–40.00	38.00–40.00	35.00–38.00	25.00–40.00
Phenylacetic-acid	14.00–16.00	14.00–16.00	12.00–20.00	8.00–9.00	5.50–6.00	5.00–5.50
Rhodinol	24.00	20.00–22.00	20.00–22.00	20.00–22.00	24.00–26.00	24.00–26.00
Imported		30.00	30.00	22.00–24.00		
Safrol				.80–.90	.80–.90	.80–.90
Terpenol C. P	.90–1.00	1.25	1.25	1.50	1.50–2.00	1.15–1.25
Imported		1.70	1.70	2.00	2.00–2.50	2.00–2.50
Thymol	6.00–6.50	6.50–7.00	12.50	12.50–13.00	12.50–13.00	11.00–11.50
Vanillin	.65–.69	.75–.80	.95–1.05	.95–1.00	.95–1.00	.85–.90
Violet, artificial	12.00–18.00	12.00–18.00	12.00–18.00	12.00–18.00	[2] 15.00	[2] 15.00

[1] Per ounce.

[2] Ionone.

Substances preparations, and mixtures used in the manufacture of perfumery—Rates of duty.

Act of—		Tariff classification or description.	Rates of duty, specific and ad valorem.
Year.	Par.		
1913	49	"* * * and all natural or synthetic odoriferous or aromatic substances, preparations, and mixtures used in the manufacture of, but not marketable as, perfumes or cosmetics; all the foregoing not containing alcohol and not specially provided for in this section."	20 per cent.

Court and Treasury Decisions.

Coumarin, shown by the evidence to be chiefly used in making flavoring extracts, was held dutiable as a chemical compound under paragraph 5, and not to come within paragraph 49 of that act. (Abstract 41691.) But the provision for coal-tar flavors in Group III of section 500 of the act of September 8, 1916, was held to control over the provision for chemical compounds in paragraph 5 of the act of 1913. (Abstract 43265.)

In another case, however, synthetic coumarin, classified by the collector as a coal-tar flavor at 30 per cent ad valorem under Group III, section 500 of the act of 1916, and claimed by the importer to come within Group II at 15 per cent plus 2½ cents per pound, was found by the Board of General Appraisers from the testimony in that case to be used in substantial quantities both for flavoring and for perfumery purposes, but not as a flavor in its condition as imported and was held dutiable at the rates claimed by the importer. (Abstract 43261.) But a different conclusion was reached by the Court of Customs Appeals. Because shown by the record not to be used as a flavor in its imported condition but as a material in the manufacture of flavoring extracts, synthetic coumarin was held not to come withing the provision for flavors in Group III as classified by the collector nor within the provision for "all similar products" in Group II as claimed by the importer and held by the Board of General Appraisers, but being substantially used in the manufacture of perfumery, though chiefly used in the manufacture of flavoring extracts and concededly odoriferous or aromatic it was dutiable under the provision in paragraph 49 of the act of 1913 for "all natural or synthetic odoriferous or aromatic substances, preparations, and mixtures used in the manufacture of, but not marketable as, perfumes or cosmetics." The court said that paragraph 49 does not require for classification thereunder, that the merchandise should be chiefly used in the manufacture of perfumery or cosmetics, but that a substantial use in such manufacture was sufficient. (United States *v.* Lehn, 9 Ct. Cust. Appls. 309.)

Compound oils which must be diluted with alcohol and further processed before becoming practically and commercially perfumery were held dutiable at 20 per cent ad valorem under the provision in paragraph 49 of the tariff act of 1913 for "all natural or synthetic odoriferous or aromatic substances, preparations, and mixtures used in the manufacture of, but not marketable as, perfumes or cosmetics," and not at the 60 per cent rate imposed in paragraph 48 on perfumery. (G. A. 8352, T. D. 38446; Abstract 43940.)

Synthetic Perfume Materials—Miscellaneous.

Synthetic perfume preparations imported into the United States during the fiscal year 1914.

[Data presented are taken from the census of chemicals and allied products imported into the United States in 1914, Department of Commerce, Miscellaneous Series No. 82.]

COAL-TAR PERFUMES.

Article.	Quantity.	Value.	Article.	Quantity.	Value.
Acetophenone (hypnone or phenylmethyl ketone)	*Pounds.* 236	$469	Musk—Continued. Trinitro-meta-butyl toluene	*Pounds.* 6,667	$6,174
Benzyl, acetate	12,197	5,893	Xylene	1,907	1,684
Benzyl alcohol, commercial	3,012	1,669	Nerolin (beta-naphthol methylic ether)	352	813
Cinnamic aldehyde	6,066	4,934	Orchidee (isoamyl salicylate)	1,410	991
Diphenyloxide (geranium oil, artificial)	5,982	5,944	Phenylethyl alcohol	1,198	6,404
Heliotropin (piperonal methylene procatechine aldehyde) crystals	10,219	8,715	Phenyl acetic aldehyde	358	2,169
Methylanthranilate	779	1,537	Phthalic ester (ether)	6,625	3,412
Musk: Artificial and ambrettol	724	5,550	Yara yara (methyl-beta-naphthyl ether)	374	435
			All other	10,268	8,611
			Total	68,374	65,404

Synthetic perfume preparations imported into the United States during the fiscal year 1914—Continued.

COAL-TAR FLAVORS.

	Quantity.	Value.		Quantity.	Value.
Coumarin:	*Pounds.*		Vanillin-methyl protocatechine aldehyde	*Pounds.* [1] 38,472	$7554
Powdered	2,303	$4,914			
Flakes	14,205	31,562			
Crystals	27,206	68,376	Total	46,119	112,406

[1] Ounces.

SUBSTANCES, PREPARATIONS, AND MIXTURES, ODORIFEROUS OR AROMATIC, USED IN THE PREPARATION OF PERFUMES AND COSMETICS (NOT CONTAINING ALCOHOL).

[Only most important articles shown separately.]

Article.	Quantity.	Value.	Article.	Quantity.	Value.
	Pounds.			*Pounds.*	
Anethol	495	$890	Lilacine	3,328	$1,378
Anisic aldehyde	507	695	Lily-of-the-valley	3,084	7,691
Atonone (synthetic violet)	120	828	Linalool	406	1,406
Aubepine:			Linalyl acetate	471	2,206
Technical	1,302	864	Muguet	355	6,431
Liquid	2,101	2,901	Musk, artificial, extra soluble	388	1,493
Crystals	230	793	Orange flower	25	1,810
Perfumery, aromatic bouquet	249	1,616	Orris oil	1,087	3,177
Bromostyrol	165	610	Parquerette (daisy) essence	35	832
Carnation	596	2,007	Pelargon (geranium, artificial)	1,021	1,728
Cinnalin	27	1,896	Raldeine violet	68	1,089
Citral	1,771	3,867	Reunia (combination of geraniol and citronellol)	303	576
Citronellol	1,062	1,853	Rhodinal (alcohol with odor of roses; sometimes applied to geraniol)	181	1,493
Citronellol A	464	2,465	Rosaldeine	95	2,185
Cyclosia	106	3,829	Rosalin	421	1,624
Cyclamen	32	1,175	Rose	8,300	10,299
Dianthol	175	2,907	Safrol	161,194	35,001
Ergamil crystals	505	753	Syringa	324	6,753
Ethyl geraniol	1,476	4,356	Tantal essence	4,444	9,766
Eugenol, crude and other	490	991	Terpineol	141,745	32,962
Geraniol (T. R. and pure C.)	2,727	6,338	Terpineol acetate	19,473	10,412
Geranyl acetate	198	634	Urdiol	634	12,165
Geranium leaves (artificial)	2,497	2,857	Verveine essence	500	1,820
Gilly flower, quarantine	369	1,076	Violet, crystal, etc	1,962	11,426
Hyacinth (100 per cent, new and blossom)	1,037	7,035	Violet oil (synthetic and artificial)	1,105	5,586
Hyacinthin	303	853	Violette (for soap, etc.)	15,593	2,816
Iralia (an orris violet of unusual strength)	160	3,634	Ylang Ylang (essence of)	246	3,439
Irisolette	915	4,919	All other	64,667	139,424
For soap	800	2,466			
Irisone	2,041	8,594	Total	455,704	416,231
Jasmine	813	18,581			
Lilac (for soaps)	325	2,722			
Lilac flowers, artificial	191	4,238			

HEALING AND COURT PLASTERS.

[Par. 50, Act of 1913, 15 per cent ad val.]

General Information.

DESCRIPTION AND USES.

Healing and curative *plasters* are intended for external application. They are usually pliable at the temperature of the body. The plastic material may be "lead plaster" (a lead soap made by beating together equal parts of lead oxide, olive oil, and lard), some mixture containing crude rubber, or a mixture of resinous substances with fats and waxes. The substances are spread upon linen, muslin, paper, or leather before using. The active principle used in the plaster depends upon the curative action desired.

Adhesive plasters are used in surgery to keep dressings in place, to cover ulcers, and to strengthen weak muscles. *Court-plaster* is made by applying to silk a coating of isinglass and tincture of benzoin.

Plasters, healing or curative, and court-plaster—Imports for consumption—Revenue.

[Under general tariff.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:						*Per cent.*
1908	35 per cent		$9,460	$3,311		35
1909	do		8,279	2,897		35
1910	do		918	321		35
	25 per cent		4,493	1,123		25
1911	do		3,964	991		25
1912	do		4,589	1,147		25
1913	do		4,639	1,159		25
1914	do		1,408	352		25
	15 per cent		9,521	1,428		15
1915	do		7,171	1,075		15
1916	do		8,094	1,214		15
1917	do		7,571	1,135		15
1918	do		5,531	829		15
Calendar years:						
1918	do		7,353	1,103		15
1919	do		6,137	921		15

Court and Treasury Decisions.

Volcanic earth dried and ground in a mill and used for external application to the human body is not within this provision. (4 Ct. Cust. Appls., 15, of 1913.)

Court-plaster cut into diminitive forms such as stars, etc., although reported to be used for adornment of the face and not medicinally, was held to be dutiable under the eo nomine provision for court-plaster

rather than under the provision for toilet preparations. (Abstract 26049, T. D. 31757, of 1911.) However, *cotton velvet articles*, one side gummed, known as beauty spots, used on the face to enhance the brilliance of the complexion, and not as coverings for wounds, are properly dutiable at the rate of 40 per cent as articles of cotton velvet under paragraph 257, act of 1913, rather than as court-plaster. (G. A. 8226, T. D. 37887, of 1919.)

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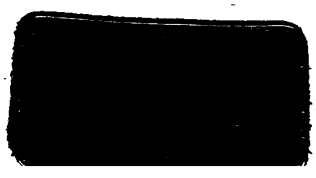

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UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPH 47 OF THE TARIFF ACT OF 1913

OPIUM, COCAINE, AND THEIR DERIVATIVES

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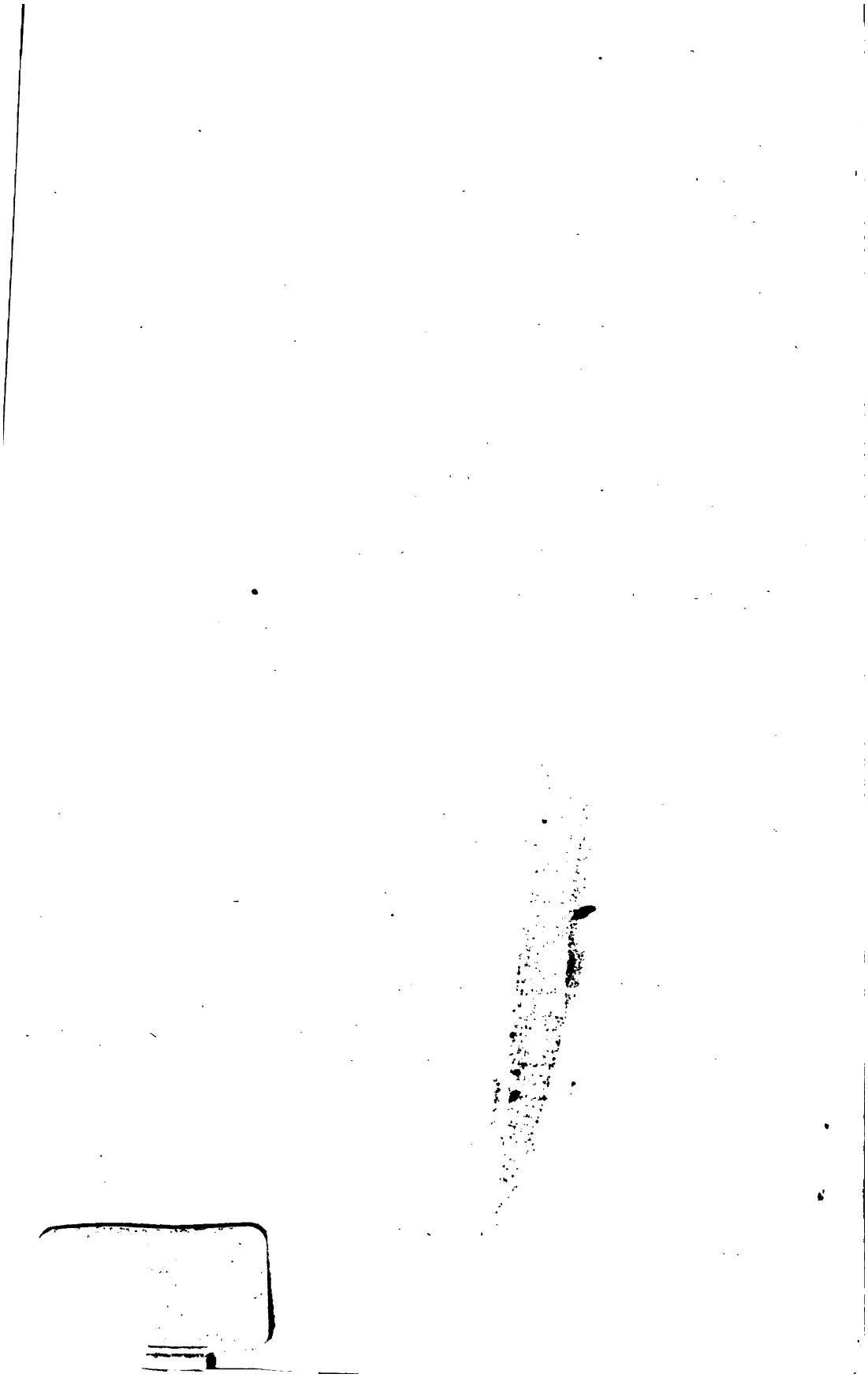

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ON THE ARTICLES IN

PARAGRAPH 47 OF THE TARIFF ACT OF 1913

OPIUM, COCAINE, AND THEIR DERIVATIVES

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PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and Index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of E. E. Stanford and Dr. Grinnell Jones, of the chemical division of the commission's staff, and of others.

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OPIUM.

(Paragraph 47, Act of 1913.)

SUMMARY.

Description.—Opium is a drug consisting of the air-dried juice of the opium poppy. It is used to induce sleep and insensibility to pain and in the manufacture of its alkaloids, chiefly morphine and codeine. (See Opium, derivatives of.) One pound supplies about 7,000 medicinal doses. The vicious use of opium and its preparations by drug addicts has become a widespread and serious public menace and has resulted in various State and Federal restrictive legislation and international treaties and agreements, which are discussed under "General Information" and "Court and Treasury decisions." The International Opium Convention, an important international agreement restricting the opium trade, is discussed on pages 12 and 13.

Domestic production.—Opium has often been experimentally produced within the United States, but costs are at present considered prohibitive. The poppy is extensively raised for seed in California. Because of the moral dangers attending the production of the drug, poppy culture in our tropical possessions has been discouraged.

Foreign production.—Commercial opium is derived mainly from Asiatic Turkey and Persia. There it is produced by cheap labor, under exceptionally favorable climatic conditions. The alkaloid content of Turkish and Persian opium is higher than that of other important producing countries. The high percentage (over 9 per cent morphine) unfits it for smoking purposes. India and China formerly produced enormous quantities of opium, of low alkaloidal content, used chiefly or wholly by opium addicts. East Indian cultivation of the poppy has recently been much restricted, and the formerly extensive trade between India and China has been stopped. Opium production in China has been prohibited for some years; recent reports indicate that the present Government has taken a firm stand to eradicate it.

Greece, Bulgaria, and a number of other countries produce varying amounts of opium, but under normal conditions their product is commercially unimportant.

Imports.—American imports of opium are contributed in normal times chiefly by Turkey, and under war conditions principally by Persia. Opium from other sources has usually been barred because of its low alkaloidal content. Trade is chiefly direct, but considerable quantities have come via England and Germany.

Three principal trade classes of opium may be distinguished.

(1) Crude opium containing 9 per cent and over of morphine; (2) dried or advanced opium; and (3) opium containing less than 9 per cent of morphine. The latter includes smoking opium. Normally the trade in the first grade largely predominates, but under

war conditions the more concentrated product has passed it in value Importations of low-grade opium prior to 1909 were used wholly for smoking purposes; smoking opium was barred absolutely by act of Congress effective April 1, 1909. Since that date no low-grade opium has entered the customs.

American imports are used both for consumption and manufacture of alkaloids. Statistics of the relative amounts used for each purpose have not been available. Alkaloid production doubtless largely predominates.

Imports of crude opium for the years 1909 [1]–1915 were very constant in amount. For these years the average annual amount is 428,634 pounds and the average annual value $1,787,162. The marked decreases of the three succeeding years may be held due solely to war conditions, of which severance of supplies and continental demand for Army use are of chief importance. In 1918 only 21,342 pounds, valued at $265,283, are reported. Imports of advanced opium have increased under war conditions. For the years 1910–1918 an average annual amount of 57,126 pounds and an average annual value of $486,337 is reported. Nineteen hundred and eighteen imports are considerably in excess of the average—98,498 pounds, valued at $1,514,127.

Import revenues of opium and its derivatives greatly exceed those of all other drug products combined. For the years 1909–1916 crude opium has yielded an average annual revenue of $671,969, and the dried or advanced grade for 1910–1918, $177,094.

The principal import restrictions on opium and its products may be found on page 32.

Prices.—Import declared values of crude opium were relatively stable prior to 1917, ranging (1909–1916) from $3.27 to $5.25 per pound. In 1917 and 1918 $7.69 and $12.43 are respectively reported. The advanced grade fluctuated between $4.48 and $8.28, and in 1918 rose to $15.37.

Domestic wholesale prices of crude opium, from $8.25–$8.30 in 1915, rose to $30–$35 per pound in 1917, but declined to $22.50 in December, 1918. The price of powdered opium during the same period ranged from $1 to $2 higher (difference in duty, $1).

Tariff history.—Opium is first specifically mentioned in the free list of the tariff of 1832. Tariffs of subsequent years levied the following imposts: 1842, 75 cents per pound; 1846, 20 per cent ad valorem; 1861, $1 per pound; 1862, $2 per pound; smoking opium, 80 per cent ad valorem; 1864, $2.50 per pound, smoking opium 100 per cent; 1870, $1 per pound, smoking opium, $6. In 1883 opium was first graded according to morphine percentage, that below 9 per cent being considered intended for manufacture of smoking opium and forbidden entry. The duty on the medicinal grade was reduced to $1 per pound. Smoking opium was taxed $10 per pound in 1883, and placed at $12 in 1890, together with that below 9 per cent, which was again allowed entry. A $6 rate was imposed in 1897, and this remained till the traffic in smoking and low-grade opium was outlawed by act of Congress in 1909. In 1890 medicinal opium was placed on the free list. In 1897, $1 per pound was imposed. The tariff of 1909 recognized two medicinal grades—crude opium,

[1] 1919 figures include dried and advanced opium.

at $1.50, and advanced opium, at $2. These rates were doubled in 1913.

Tariff questions involved.—The high rates recently placed on opium may presumably be referred to a desire on the part of Congress to restrict the traffic rather than to raise revenue. While the traffic in smoking opium has been largely stamped out, its place has been taken by various other forms of opiumism, of which addiction to morphine and heroin are probably chief. The effect of tariff levies on addiction of this sort may be judged by a study of the prewar importations, which vary little under different acts, and by the fact that a pound of 9 per cent opium, imported normally at a value below $8 and taxed $3, contains 7,000 one-grain medicinal doses, or may be manufactured into about 5,000 doses of morphine.

A number of congressional enactments in recent years have been intended to promulgate necessary restrictions on opium use and thereby, presumably, relieve tariff legislation of the necessity of further functioning in this manner. Chief of these may briefly be noted the Federal food and drugs act, providing for the proper labeling of opium preparations; the acts of 1909 and 1914, prohibiting the import and (virtually) the manufacture of smoking opium, as well as establishing regulations for the entry of the medicinal grade; the Harrison narcotic law, providing for the registration and tracing of opium preparations; and the narcotic section of the recent war revenue bill, which last enacts in slightly different form certain punitive clauses of the Harrison law which have been declared unconstitutional.

General Information.

Opium is the air-dried milky exudation obtained by incising the unripe capsules of *Papaver somniferum* L. (*P. officinale* Gmel.) and its variety *album* D. C. (family papaveraceae).

GRADES.

Opium is commercially valued according to its percentage of its principal alkaloid, morphine (referred to in the tariff as morphia).

The United States Pharmacopœia defining opium as above, further specifies, "yielding, in its normal moist condition, when assayed as directed * * * not less than 9.5 per cent of morphine."

The tariff act of 1913 lists the following grades: "Opium, crude or unmanufactured, and not adulterated, containing 9 per centum and over of morphia, $3 per pound.

"Opium of the same composition, dried to contain 15 per centum or less of moisture, powdered, or otherwise advanced beyond the condition of crude or unmanufactured, $4 per pound."

"Opium containing less than 9 per centum of morphia, $6 per pound."

The act further provides "That nothing herein contained shall be so construed as to impair or affect the provisions of an act entitled 'An act to prohibit the importation and use of opium for other than medicinal purposes,' approved February ninth, nineteen hundred and nine."

This act, in its effect, prohibited the importation of all but the two higher grades of opium above enumerated; the low-grade opium being used almost wholly for smoking purposes.

SOURCES OF SUPPLY.

The principal opium-producing countries are Turkey, Persia, India, and China. Turkish opium is the highest grade, and has been the chief variety consumed in America. The war has naturally resulted in cutting off the supply of Turkish opium, and its place has been taken to some extent by Persian opium. Indian and particularly Chinese opium are comparatively low in morphine content, have been used chiefly in the preparation of smoking opium, and are not imported into the United States. A large proportion of Turkish opium arrives via England.

HISTORY OF OPIUM.

The opium poppy is probably indigenous to southern Europe and western Asia. The medicinal properties of the juice have been known for a very long period. It was mentioned by Theophrastus (372–287 B. C.). From the first to the twelfth centuries the opium of Asia Minor appears to have been the only kind known in commerce. Reference to the production of opium in India is found early in the sixteenth century. The spread of the poppy thence is said to have been connected with that of Mohammedanism. In the seventeenth century Persian opium is described; the best sorts were flavored with spices and called "theriaka," and greatly prized during the Middle Ages. The poppy has been known in China some 12 centuries and its medicinal uses for 9. Opium, however, was not extracted in China till about the sixteenth century.

Origin of use of opium.—Opium smoking appears to have originated with the Dutch in Java, and by them taken to Formosa, whence it spread to the mainland about the middle of the seventeenth century. The drug was not then, as now, smoked by itself, but as a mixture with tobacco. Probably it was not smoked alone till near the end of the eighteenth century. Something of its deleterious effect was early recognized, for opium smoking was first prohibited by the Chinese Emperor Young Cheng, in 1729. At that time opium was imported in small amounts from India, as well as produced locally. The early opium trade with China was in the hands of the Portuguese, but the East India Company, who had secured a monopoly of Indian opium in 1757, took charge of the Chinese-Indian trade in 1773. Chinese imports increased from 150,000 pounds in 1776 to 758,000 pounds in 1790. The Chinese Imperial authorities, alarmed by the rapid spread of the vice, in 1796 again prohibited opium smoking, and followed this with a prohibition of importation in 1800. Although infractions of these edicts were punishable with severe penalties, and even with death, the trade continued, and during 1820–1830 increased to some 2,527,000 pounds per year. In 1839 the first serious attempts were made by the Chinese authorities to stop the trade; 3,030,000 pounds of opium, valued at $9,740,000, was destroyed by the Chinese commissioner at Canton. This was the property of British traders. The traders still sought to smuggle opium ashore, and the result was the so-called

"Opium War," between Great Britain and China. This ended by the treaty of Nanking, in 1842. Opium was not mentioned in this treaty, but its importation continued and was legalized under certain restrictions in 1858. In this year some 10,430,000 pounds were imported into China. The status of the opium question at this period was a marked proof of the inherent weakness of the Chinese Government; while the central authorities were honestly striving to discourage production and trade, several of the provincial viceroys were actively encouraging it. By the beginning of the twentieth century opium was produced in every Province in China. The total amount produced in China in 1906 was estimated at 44,000,000 pounds, of which two-thirds was produced in Szechuan. About 7,230,000 pounds were imported, chiefly from India, and about 631,000 pounds exported, chiefly to Indo-China.

Early Indian-Chinese trade.—During the latter part of the nineteenth century and the first years of the twentieth the opium trade was the chief source of Indian revenue. The total net receipts from the export trade of India for the years 1900–1909 never fell below £3,000,000, and in one year (1904–05) exceeded £4,000,000. The gross revenue from opium excise (for consumption within India) varied in this period from £676,000 to £986,000. Repeated efforts by persons in India and England to bring about the discontinuance of the trade on moral grounds were for a long time without effect. In 1893 an extensive inquiry was made into all phases of the Indian opium question by a commission appointed by Parliament. This commission rendered a voluminous report in 1895, which in substance stated that the evils attending the opium traffic had been much exaggerated; that it was not necessary, advisable, or demanded by the Indian people that the growth of the poppy and manufacture of opium except for medicinal purposes should be abandoned in India; that the finances of India were not in a condition to bear the cost of the preventive measures and the loss of revenue which would be entailed by prohibition; and that they found "no evidence of extensive moral or physical degradation" resulting from the use of opium. A single member filed a dissenting report, in which he disagreed especially with the last-cited conclusion of the commission, and sharply arraigned the administrative methods of the Indian government and its attitude toward the inquiry. The report of the commission put an effectual quietus on the antiopium movement for a number of years.

Opium in the Philippines.—The next important era in the history of opium may be said to have opened with the acquisition of the Philippines by the United States. While the United States, in its "Chinatowns" and in its treaty and trade relations, had encountered the opium traffic and adopted certain policies with regard thereto, it now for the first time came seriously into contact with the problem. In the Philippines were about 70,000 Chinese, the majority in the larger towns, Manila alone containing 40,000. A large proportion of these were opium addicts. Under the Spanish law the sale of opium was farmed out and smoking resorts licensed, for the Chinese only. It was unlawful for a Filipino to use opium in any way. Under American occupation the Spanish law was not continued in force. A duty was placed on opium, and towns were enjoined to forbid the establishment of opium dives. Under this system the use of the drug spread rapidly among the Filipinos.

In 1903 the Philippine Commission appointed an opium committee, authorized to visit the various oriental countries to investigate the methods taken by the different Governments toward the regulation of opium use and traffic. This committee investigated conditions in Japan, Formosa, Shanghai, Hongkong, Saigon, Straits Settlements, Burma, and Java, and rendered a report in 1904. The recommendations of this report were based largely on the experience and methods of the Japanese upon their acquisition of Formosa in 1895. The most important recommendations were: Immediate Government monopoly of the traffic in opium, to become prohibitive, except for medical purposes, after three years. The partial adoption of these suggestions are seen in an act of Congress entitled "An act to revise and amend the tariff laws of the Philippine Islands, and for other purposes," approved March 3, 1905. This act provided duties on crude and manufactured or smoking opium, but left the Philippine Commission free to prohibit or regulate the use of the drug, and provided further "That after March 1, 1908, it shall be unlawful to import into the Philippine Islands opium, in whatever form, except by the Government, and for medicinal purposes only, and at no time shall it be lawful to sell opium to any native of the Philippine Islands except for medicinal purposes." The Government monopoly plan was not adopted.

Inception of Chinese antiopium movement.—The rather voluminous report of the committee gave a new life to the antiopium movement in all countries affected by the drug, and it is not unreasonable to attribute to it the sudden renewal of activity by the Chinese Government, which, while officially discountenancing the use of opium, derived a large revenue from it and had appeared to feel itself unequal to a vigorous opposition to what had become probably the gravest internal menace ever faced by any nation. It has been estimated that 27 per cent or over of Chinese adult males were opium smokers. On September 20, 1906, the central Government of China issued an edict forbidding the consumption of opium and the cultivation of the poppy. In October of the same year the American Government in the Philippines suggested a joint conference of the powers interested with a view to united action against the opium traffic. In 1907 the British Government offered to reduce the export of Indian opium 5,100 chests—i. e., one-tenth of the amount then taken by China each year till 1910, and offered further, if the Chinese Government should proportionately decrease opium production in China, and its importation from the other sources, to continue this annual reduction till the trade should be extinct in 1917. This proposal was gratefully received by the Chinese Government, which vigorously carried out its part of the agreement.

First International Opium Conference.—In 1909 the first International Opium Commission, convening on the initiative of the United States Government, met at Shanghai. The powers represented were the United States, Austria-Hungary, China, France, Germany, Great Britain, Japan, the Netherlands, Persia, Portugal, Russia, and Siam. Each of these countries presented a report embodying the regulations and describing the status of the opium traffic within its territories. The most extensive report was that submitted by the Chinese delegates, who, in addition to statements regarding opium proper, called attention to the recent rapid increase in the vicious use of

morphine and cocaine, both of which had been widely introduced, both openly and as recent ingredients of opium "cures" and "remedies" with which the country had been flooded, chiefly by foreign agents.

The commission adopted nine resolutions for presentation to the respective Governments concerned. In these the commission recognized the sincerity of the Chinese Government in the antiopium movement. It urged each Government concerned to take measures toward the suppression of opium smoking, to prevent the shipment of opium and its derivatives to countries prohibiting their import, and to take drastic measures in regulation of the manufacture and use of morphine and other habit-forming opium derivatives. It further recommended that antiopium remedies and opium and its derivatives be subjected to scientific inquiry, that opium shops and divans in foreign concessions in China be closed, and that the sale of antiopium remedies containing opium or its derivatives be prohibited, and that the pharmacy laws of the governing nation be applied in such concessions.

Continuance of Chinese antiopium movement.—During the years 1906–1910 the Chinese antiopium movement continued with variable but, on the whole, unlooked-for success. In 1911 an agreement was signed between China and Great Britain, ratifying and completing the tentative arrangement of 1907, and furthermore providing for the extinction of the Indian trade with different Provinces of China as fast as each Province should suppress local production. China also prohibited the import of Turkish and Persian opium after 1911. To conclude the history of opium as regards China, it may be said that the prohibitory movement received a serious setback during the revolution, but by 1914 the new Government had apparently full control of the situation and was carrying out systematic and progressive prohibition as planned by the old régime. As an aid to the new Government in the suppression of the opium traffic, the Indian Government in 1913 prohibited the export of opium to China. A considerable amount of smuggling, however, still takes place across the national boundaries.

International Opium Conference, 1911–1913.—On December 1, 1911, an International Opium Conference met at The Hague on the initiative of the United States Government. All the powers represented in the previous commission, with the exception of Austria-Hungary, took part. On January 23, 1912, the so-called international opium convention was signed by the plenipotentiaries of the different powers. This convention provided, with regard to raw opium, that the contracting powers should regulate the production, distribution, limit the ports through which the export or import should be permitted, take measures to prevent or restrict the export to countries which should have prohibited or restricted its import, require marking indicative of its contents on every package exceeding 5 kilograms intended for export, and not to allow its export or import save by duly authorized persons. With regard to prepared opium, i. e., opium prepared for consumption not medicinal, the convention provided for the gradual and effective suppression of its manufacture and trade and for the prohibition of its export immediately or "as soon as possible"; in the latter case regulative measures similar to those for raw opium were outlined. The convention further provided for the control by

the contracting powers of the manufacture, sale, and use of morphine, cocaine, and their respective salts, medicinal opium, preparations containing more than 0.2 per cent of morphine or more than 0.1 per cent of cocaine, of heroin, its salts and preparations containing more than 0.1 per cent of heroin, and of all derivatives and salts of morphine or cocaine liable to similar abuse. With regard to China, the contracting powers already having treaties (so-called treaty powers) pledged themselves to take measures to prevent smuggling into Chinese territory or their own far eastern colonies and leased Chinese territories of any of the substances above referred to, the Chinese Government to take similar measures to prevent smuggling from its own territories to those of other powers. Other provisions related to the promulgation of pharmacy laws for China and adjacent territories, to reduction of opium dens and shops, and to transmission of the drugs mentioned in the convention through the mail. Provision was made for the signature of nonrepresented nations to the convention and for its final ratification.

The second meeting of the conference was held in 1913.

By July 3, 1913, 36 powers had signed the convention, of which 23 had agreed to deposit ratifications. Only 10 nations, Bulgaria, Greece, Turkey, Switzerland, Austria-Hungary, Norway, Sweden, Rumania, Montenegro, and Serbia, had not signed; of these only Turkey is of importance in production or trade in opium or the other narcotics included in the convention.

AMERICAN LEGISLATION REGARDING OPIUM.

Opium has figured in American treaties, international conventions, tariffs, prohibitory laws, and internal-revenue laws, as well as in the legislation of different States. State legislation will not here be considered.

TREATY PROVISIONS RELATING TO OPIUM TRAFFIC.

By a treaty with China in 1880 the importation of opium into the United States by Chinese subjects was prohibited, and citizens of the United States were prohibited from traffic in opium in China. By a treaty of 1903 the United States consented to the prohibition by the Chinese Government of morphia and instruments for its injection for purposes other than medicinal. A treaty with Korea similar to that of 1880 with China was concluded in 1882. By a treaty with Siam in 1856 American subjects were permitted to import opium into Siam, but were allowed to sell it only to the Government opium farmer or his agents.

Although not a treaty, a statute of 1902 may here be mentioned forbidding the sale or supply by persons subject to the authority of the United States of opium to the aboriginal inhabitants of the Pacific islands lying within the parallels of 20° north and 40° south latitude and the meridians of 120° west and 120° east of Greenwich.

FEDERAL STATUTES AND INTERNAL-REVENUE LAWS RELATING TO OPIUM.

By an internal-revenue law of 1890 a tax of $10 per pound was placed on the manufacture of smoking opium within the United

States, and its manufacture was confined to citizens. The contemporary tariff duty on smoking opium was $12 per pound. No legalized manufacture took place under this statute.

The national food and drugs act of June 30, 1906, provided for the proper labeling of opium and preparations containing it; it also provided that "if * * * any article of food or drug offered to be imported into the United States is * * * dangerous to the health of the people of the United States, or is of a kind forbidden entry into, or forbidden to be sold or restricted in sale in the country in which it is made or from which it is exported * * * the said article shall be refused admission." This provision was utilized to exclude importations of smoking opium. The enforcement of the act and of State laws founded upon it limited in large measure the secret use of opium and its derivatives in proprietary remedies, which had become a serious public menace.

An act of Congress entitled "An act to prohibit the importation and use of opium for other than medicinal purposes" was approved February 9, 1909. This was strengthened by an amendment imposing severe penalties on violation, approved January 17, 1914. A further act, approved January 17, 1914, placed an internal-revenue tax of $300 per pound on smoking opium manufactured in the United States and provided a penalty of not less than $10,000 or imprisonment for not less than five years, or both, for violation of its provisions. This act owed its passage to the announced intention of certain persons to produce opium in California and to manufacture it for smoking.

Further Federal legislation dealing with opium is the Harrison narcotic law, approved December 17, 1914. This was the result of years of effort on the part of the authorities charged with the administration of the food and drugs law and of similar State laws, and of others interested in the suppression of the nonmedicinal use of narcotics. This law relates to the production, importation, manufacture, compounding, sale, dispensing, or giving away of opium or coca leaves, their salts, derivatives, or preparations. It provides for the registration of persons authorized to deal in these products, confines dealing in them to such registered persons, and provides for the proper record of all such products from their entry into the country to the ultimate consumer. The provisions of the act do not apply to preparations containing not more than 2 grains of opium, one-fourth of a grain of morphine, one-eighth of a grain of heroin, 1 grain of codeine, or any salt or derivative of any of them to 1 ounce, provided that such preparations are used as medicines and not for the purpose of evading the act. Violation of the provisions of the act are punishable by fine of not more than $2,000 or imprisonment of not over five years.

Reasons for this restrictive legislation may be found in the hearings before the House Committee on Ways and Means on H. R. 25240, 25241, 25242, and 28971 (1910–11). They may be briefly summed up in the statement (p. 82) that, while "an estimate from leading members of the medical profession [states that] 50,000 pounds of opium [annually] will suffice for the legitimate needs of the American people," annual importations were from 400,000 to over 500,000 pounds. The number of American opium addicts was estimated at 150,000.

TARIFF LAWS ON OPIUM.

Prior to 1832 no specific mention was made of opium or its derivatives in the United States tariff laws. In this year (1832) opium was removed from the category of "drugs, chemicals, etc.," and specifically mentioned in the free list. No distinction was made between grades of opium or between opium and its derivatives. By the tariff of 1842 a duty of 75 cents per pound was imposed. In 1846 this was changed to an ad valorem of 20 per cent.

In 1861 the distinction between crude opium and morphia or its salts was first made. The former was taxed $1 per pound and the latter $1 per ounce. Smoking opium was differentiated in 1862. This was largely due to the fact that in the latter fifties our opium imports had reached an enormous figure (100,000 to 150,000 pounds annually) and that it consisted largely of smoking opium imported into Pacific ports ostensibly for use of the Chinese. While opium had been previously treated as a pure revenue article, an effort was now made to tax only medical opium on this basis and to place a prohibitive tax on smoking opium. Medicinal opium was taxed $2 per pound and the smoking article 80 per cent ad valorem. In 1864 these duties were raised to $2.50 per pound and 100 per cent ad valorem, respectively. These high duties upon smoking opium proved in effect prohibitive, as far as legitimate imports were concerned, but an enormous smuggling trade immediately developed.

In the tariff of 1870 the duty on medicinal opium was reduced from $2.50 to $1 per pound. Smoking opium paid a specific tax of $6 per pound. Its declared valuation was then about $10 per pound. This allowed importations varying generally from 50,000 to 77,000 pounds annually, and rising to 298,000 pounds in 1883 in anticipation of raised rates.

During the discussion of the next two tariffs there was a popular demand for the exclusion of smoking opium. This was largely due to the treaty of 1880 with China, referred to elsewhere, and to the fact that the opium-smoking habit was evidently spreading from the Chinese to the American people. The tariff of 1883 first graded raw opium according to its morphine percentage. Opium containing less than 9 per cent of morphia, which grade formed the raw material for the manufacture of smoking opium, was forbidden entry. The tariff of 1883 placed a specific duty of $10 and that of 1890 of $12 on smoking opium, while the medicinal grade entered in 1883 at $1 and was placed on the free list in 1890. Opium containing less than 9 per cent of morphia was dutiable at the same rate as smoking opium and continued in the same category until the prohibition of the latter's entry. These rates continued till 1897. Smoking opium was imported openly, and also smuggled enormously. In 1897 the $6 rate was restored and remained until the traffic was outlawed in 1909.

Medicinal opium was again dutiable at $1 under the tariff of 1897.

By the tariff of 1909 opium containing 9 per cent or over was taxed $1.50 per pound; that of the same composition, dried or advanced, $2 per pound; and that containing less than 9 per cent, $6 per pound. The tariff of 1913 doubled the rate on medicinal opium and left the nonmedicinal grade at the same rate, $6.

PRODUCTION AND COMMERCE.

General considerations.—The production of opium may be said to be possible in any temperate or subtropical climate where the rainfall is not excessive. Experiments in the growth of the poppy and the collection of opium have accordingly been carried out in practically every agricultural country. It has been found, however, that the yield is smaller in temperate than in subtropical regions, and that the morphine content of the product varies widely in different localities. Profitable opium production is dependent both on plentiful supplies of cheap, rich land and of cheap skilled labor. The commercial production of opium is therefore limited to comparatively few countries, and the varieties of poppy grown, the methods of cultivation and handling used, and the character of the opium produced vary widely. In some countries where the production of opium is not profitable the capsules, which contain on the average 0.2 per cent of morphine, are gathered and used medicinally. The seed crop is second only in importance to the opium; the seed yields 35 to 42 per cent of a valuable oil, which is used both for food and for technical purposes, while the pressed cake is used as stock feed and fertilizer. No narcotic properties are present in the seeds.

Turkish opium.—The variety *glabrum* supplies Turkish opium. It is chiefly produced in Asia Minor. Cultivation is carried on mostly by peasant proprietors. Poppy cultivation demands a naturally light and rich soil, manured, and with a rather particular amount of moisture. The land is plowed twice. Owing to droughts, spring frosts, and locusts, the crop is a most uncertain one. As a safeguard against total failure and to provide a succession of crops, three sowings are made at intervals from October to March. The first sowing thrives best in normal seasons; the other two are particularly dependent on favorable weather. Continual cultivation is practiced, chiefly by women and children, from early spring to flowering time, which occurs from the end of May to July, the period of flowering from a given sowing being comparatively short. The yield of opium is largely increased by gentle showers during the flowering period. The capsules are fit for opium collection in 9 to 15 days from the falling of the petals. They are capable of yielding the drug to advantage only from 5 to 10 days when the crop is a full one; therefore great quantities are usually wasted owing to the difficulty of gathering the whole in this short period. A smaller second or third crop may be obtained from the heads produced by the branching of the primary stem.

The incision of the capsules demands a peculiar skill. The incisions are spirally transverse, and made with a knife possessing one to three blades. If the incision be too shallow, the full yield of juice is not secured; if it be too deep, the juice flows into the hollow inside of the capsule and is lost; the seeds also are prevented from maturing in this case. Incision is performed from early afternoon to nightfall, and the exuded juice is scraped off and collected the following morning. Cold or winds during the collection period lessens the yield, and rain washes away the exuded juice. The yield of opium varies, even on the same piece of land, from one-third to 7½ chequis (of 1.62 pounds) per 1,600 square yards, an average being 1½ chequis of

opium and 4 bushels (of 50 pounds) of seed. The seed is worth about two-thirds the value of the opium. The gathered lumps are wrapped in leaves and dried for some days in the shade. The crop is then passed on to the buyers, who often have advanced money on it. By them it is sent to Smyrna or other ports on mules; here it arrives in late July or early August and is placed in cool warehouses to avoid loss of weight. The mixed assortment of opium delivered at the warehouse is known as talequale. When sold, the bags are open, and each piece is inspected by a public official, who makes three grades: (1) Finest quality, (2) current or second, and (3) chicanti or rejected pieces. A fourth sort consists of very bad or wholly spurious pieces. Adulterants found are grape juice thickened with flour, fig paste, licorice, half-dried apricots, chopped vegetable tissues, tragacanth, clay, etc. The practice of diluting a very high-grade article with one of lower quality is also common. After the inspection the two better grades are hermetically sealed in tin-lined boxes containing about 150 pounds. These are the "chests" of commerce. The chicanti is disposed of at 20 to 30 per cent discount to French and German merchants. About three-quarters of Turkish opium is produced in Anatolia, and is exported via Smyrna; the remainder is produced in the hilly districts near the southern coast of the Black Sea, and is marketed via Constantinople. Commercial varieties bear the names of the districts where they are produced; the chief varieties being Hadjikeuy, Malatia, Takat, Bagaditz, Karakissa, Angora, Ghéve, and Yoghourma or pudding opium. These commercial varieties differ in appearance and quality, and are roughly classified as soft or shipping opium, druggists' opium, and manufacturers' opium. Turkish opium is principally used for medicinal and manufacturing purposes on account of its high morphine content, a comparatively small proportion being exported for smoking or "eating." That used for the latter purposes is included in soft or shipping opium, which is lowest in morphine content. The chief markets for this have been China, Korea, the West Indies, Cuba, British Guiana, Japan, and Java. Druggists' opium is the medicinal grade, largely used in Great Britain and the United States, and containing 9½ to 10½ per cent of morphine when dried and powdered. Manufacturers' opium includes any grade containing not less than 10½ per cent of morphine, and, as the name implies, is used for the extraction of the alkaloids. It is used chiefly in Great Britain, Germany, the United States, and France.

The average amount of Turkish opium exported is given as 7,000 chests; in especially propitious seasons it may amount to 12,000 chests.

Opium has also been produced in recent years in Macedonia, most of the produce being exported as Salonica opium. It is a very pure grade and contains about 11 per cent of morphine. The Turkish Government has encouraged the opium industry in Macedonia by remitting the tithes on the opium and poppy seed for one year on lands sown for the first time, and by distributing printed instructions for cultivation of the poppy and preparation of opium. In these the claim is made that the opium crop is ten times more profitable than wheat.

Opium is also grown in Bulgaria, but for little more than local consumption. Surpluses are marketed through Constantinople as

Turkish opium. It is of high quality. Four samples exhibited at the Antwerp Exposition of 1896 contained, respectively, 7.25, 11.90, 11.07, and 19.15 per cent of morphine.

Persian opium.—The Persian poppy is apparently the variety *album.* Opium comes chiefly from the districts of Ispahan, Shiraz, Yezd, and Khansar, and also from Kermenshah, Khorasan, and Fars. Opium has been grown in Persia since a very early date, but has only appeared in the commerce of England and America since about 1870. At that time the profits in Persian opium were so great that its cultivation almost excluded that of cereals and other produce, resulting in a severe famine in 1871-72. Cultivation has increased in recent years, especially in Ispahan and about Shiraz, Beheban, and Kermenshah, where it has again affected the price and growth of cereals.

At one period Perisan opium was extensively adulterated with glucose, but the price and demand soon suffered, and of recent years strenuous and very successful endeavors have been made to standardize the product, and consequently Persian opium may now be obtained nearly as rich in morphine as the Turkish.

In 1907 the production totaled 1,333,000 pounds. About 25 per cent was locally consumed, chiefly for smoking. Great Britain took about 20 per cent, and about 50 per cent was exported to Hongkong and Singapore, most of which eventually went to Formosa and China. A small quantity went via Trebizond and Samsun to Constantinople. Persian opium is also exported to Zanzibar and probably smuggled into India. Bushire and Bander Abbas are the chief centers of export.

The greater proportion of Persian opium entering London in normal times has been exported. A small quantity is used in manufacture, particularly for the manufacture of codeine when Turkish opium is high in price. Persian opium yields 2½ per cent codeine as against one-half to three-fourths per cent in the Turkish product. Codeine, however, may also be made from morphine, which fact limits the demand for Persian opium for codeine extraction.

Persian opium usually enters commerce in brick-shaped cakes weighing 16 to 20 ounces, and differs considerably in its physical character from Turkish opium.

Indian opium.—Two chief varieties of Indian opium are recog nized—Bengal and Malwa. The former is produced in the territory controlled by the British Government; the trade is a government monopoly. The chief districts are Bihar in Bengal and the United Provinces of Agra and Oudh. Poppy growing has been licensed, and the amount of planting prescribed by the Indian government. Opium may only be sold to government officials at Patna and Ghazipore. The price is fixed by the government, and money is often advanced to the grower.

Malwa opium is produced in the native States, chiefly of the Central India and Rajputana agencies, Gwalior, Indore, Bhopal, and Mewar; also in Baroda and the British territory of Ajmer Merwara. Cultivation is free and very profitable; usually three to seven times more profitable than that of cereals, and, exceptionally, twelve to twenty times. A heavy import duty is placed on Malwa opium which enters British territory, raising its price to that of Government-monopoly opium.

Rich land, manured and irrigated, is utilized for poppy production. As in Asia Minor, the crop is an uncertain one, being liable to injury by frost, rains, insects, fungi, and a root parasite. The poppy petals are gathered, dried, and saved for wrapping the opium balls. The process of collection differs somewhat from that followed in Asia Minor; the opium is handled in a more fluid state, the composition of "standard opium" being 70 per cent of the dry drug and 30 per cent water.

Formerly two Government factories, at Patna and Ghazipore, were in operation for the preparation of opium for commerce. That of Patna has now been closed as a result of the cutting off of Chinese shipments and the reduction of the area under poppy. Indian opium is of two classes—provision opium, for export, chiefly to China before the era of prohibition, and excise or akbari opium for local consumption. Provision opium manufactured at Ghazipore is known as Benares opium. Excise opium is made into cakes and contains 90 per cent of nonvolatile solid matter, while the provision opium contains 71 to 75 per cent of solid matter, or, roughly, 50 per cent of pure opium, and is molded into balls. This manufacture is a somewhat complicated process and is carried out in the Government factories with a high degree of uniformity.

Malwa opium is manufactured by private enterprise; it is less uniform than the Bengal drug and, as a whole, is less highly esteemed. The Government levies an export duty of about $290 per chest of 133⅓ pounds. While exported opium has thus gone through a certain process of manufacture, further treatment is needed to prepare it for smoking, and it is therefore designated in the international opium convention and elsewhere as "raw opium."

Annual yields of Bengal opium have been estimated at from 8,000,000 to 10,000,000 pounds, and the acreage from 500,000 to 655,000 acres, and the number of cultivators at about 1,500,000, for the first years of the century. Acreage has been restricted by Government action since the reduction and eventual prohibition of the Chinese trade. Production of opium in Bihar has been discontinued, and the Bengal acreage reduced to 200,000 acres, all in the United Provinces (1913).

The amount of Malwa production is less certain, but has been estimated at 2,000,000 to 3,000,000 pounds annually.

Bengal opium is exported from Calcutta, Malwa, from Bombay, chiefly to China (before the prohibition of the trade) the Straits Settlements, Burma, and the South Sea Islands. Owing to the low morphine content of Indian opium, little or none enters occidental commerce, particularly since the restrictions on smoking opium which are now almost universal. The unit of export is usually the Chinese picul (133⅓ pounds); but the "chest" is a frequent trade term. In Malwa opium this is equivalent to the picul, but the Patna and Benares "chests" contain 160 pounds. The catty, a smaller unit, is 0.01 of a picul (1⅓ pounds).

Indian opium, as just noted, is normally low in morphine, 2 to 5 per cent, but occasionally samples of official strength have been reported. That grown near the Himalayas is said to be 50 per cent stronger than the average, and some attempts to encourage the production of higher grade-opium appear to have been made, especially since the reduction of the Chinese trade.

A small amount of morphine is made in a Government factory in India. The surplus above local requirements is sold in London.

Chinese opium.—While Chinese opium, in the years of its largest production, amounted to probably 40,000,000 pounds annually—double the total production of all other kinds, it has never entered commerce save for comparatively trifling quantities exported for smoking purposes, chiefly to Chinese residing in other countries. Owing to its low morphine percentage and general poor quality, practically no Chinese opium has been deemed fit for medical purposes.

The poppy has been grown in every Chinese Province, but the principal centers of production have been the western Provinces of Szechwan, Yunnan, and Kweichow. It was for many years the principal and most profitable crop of the western Provinces; here it was a winter crop, rice being generally sown in the spring. As elsewhere, the poppy is a gross feeder, quickly exhausting the soil, and requiring liberal manuring, the crop, also is uncertain and not infrequently results in disastrous losses, but in general the profit is three or four times that of any other agricultural crop. The yield of raw opium per acre averages about 28 pounds, selling at 40,320 cash, while the seeds and dried plants bring 16,500 cash; a total gross return of 56,820 cash.

As a result of the antiopium agitation of recent years, and the vigorous enforcement of prohibitory edicts by local authorities, the acreage and annual yield of Chinese opium had decreased enormously. According to a report of an expert employed by the British Government to investigate the situation, by 1910–11 poppy cultivation had been suppressed in Shansi and Szechuan and reduced in other Provinces from 75 to 25 per cent of a normal acreage. The central Government actively promoted the growth of other crops in replacement by introducing improved cotton seed from America and distributing agricultural literature. Wheat and other cereals and cotton were largely replacing the poppy, with a consequent lessening of danger of famine.

The outbreak of the Chinese revolution 1911–12, with its consequent disorganization of the central and provincial Governments, resulted in an enormous reappearance of poppy cultivation, in some cases under official sanction. In 1913 the Republic renewed the antiopium crusade with vigor, and to a large extent destroyed the crops. At the end of 1914 the only Provinces to which the entry of opium was permitted were Yunnan, Kwangtung, Kweichow, Kiangsi, Kiangsu, Shensi, and Kansu. Wheat had again replaced opium in Szechwan.

Under recent legislation, the growth of the poppy in China is understood to be punishable by death, and further provisions provide for measures calculated totally to eradicate the opium evil in China.

Japanese opium.—The production and use of opium in Japan has always been very strictly regulated. The vicious uses of the drug are prohibited under severe penalties, are condemned by public opinion, and are said to be almost unknown. The production of opium for medicinal purposes has been encouraged by the Government, but the report of the Japanese delegates to the International Opium Commission of 1909 stated that "the climate of the country is unsuitable

for the cultivation of the poppy and the production of opium has dwindled and is now quite insignificant."

A large proportion of the inhabitants of Formosa, acquired by Japan in 1895, were confirmed opium smokers. The Japanese made the opium traffic of Formosa a Government monopoly, and promulgated regulations to lead to the gradual extinction of the nonmedicinal use of opium.

Egyptian and Australian opium.—Egyptian opium was formerly of some importance, but was of rather poor quality and hardly occurs in modern commerce. Australian opium of good quality has been produced; but is not now of any importance.

European opium.—Aside from that of Macedonia and Bulgaria, the production of opium in Europe has been on little more than an experimental scale. Successful attempts, as regards production, have been carried out in England, France, Sweden, Germany, Italy, Switzerland, Spain, and Greece. Only that of the latter country is of any present commercial importance. Much of the opium thus produced has been of extremely high grade, containing 8 to 13 per cent, and even more, of morphia. In France, a small cultivation of opium was carried on at Clermont-Ferrand from 1844 till quite recently. Some specimens of this product have assayed 22.8 per cent morphia, the highest percentage thus far observed in any opium. The difficulty of obtaining a sufficient amount of cheap labor at the exact time needed and the dependence of the crop upon conditions render the commercial production of opium in Europe speculative and generally unprofitable. The poppy is cultivated for seed in Austria, France, German , the Netherlands, and Italy. In several of these countries the capsules are gathered to a small extent for medicinal use.

American opium.—Opium has been produced experimentally within a wide range in the United States, but in no place has the industry taken permanent hold. Climatic and soil conditions are favorable, but, at normal prices, the cost of cultivation and gathering is prohibitive. The poppy is not, in America, considered a soil exhausting crop. It matures for opium gathering in 90 to 100 days. During the Civil War considerable high-grade opium was produced in the Southern States. In the decade following the Civil War opium production attracted considerable attention, and was carried out locally in Vermont, Connecticut, Pennsylvania, and California with considerable profit, the price of imported opium being then comparatively high. With the lowering of price in subsequent years, interest in American opium growing subsided.

The United States Department of Agriculture carried on investigations in the growth of the opium poppy about 20 years ago, investigating the possibility of obtaining morphine, etc., from the dried capsules, but cultivation of the poppy for this purpose has never reached a commercial scale.

In California alone poppy cultivation has been quite extensive, but here the crop sought is the seed, which is consumed as a food by Syrians and other oriental residents, or used as an oilseed. The production of opium for smoking purposes was at one time projected here, but was prevented by stringent internal-revenue legislation elsewhere referred to.

USES OF OPIUM.

The uses of opium and its derivatives may be broadly classed as either medicinal or vicious, although the dividing line is not always clear. Opium (the word here includes derivatives) would probably be estimated by the majority of physicians as the most important drug in the materia medica, and at the same time the one, with the possible exception of cocaine, most liable to disastrous abuse. The habit-forming tendencies of the drug are so marked that in the therapeutic practice of to-day it is held more and more as a last resort, and above all as an occasional rather than a routine remedy.

The abuses of opium could be formerly classed under "eating" and smoking. The former vice, once common in the Occident, finds its modern analogy in the consumption of morphine and other opium derivatives. It is still prevalent in India, where its moral and physical effects have long been a subject of controversy, China, and elsewhere in the Far East. In India, in particular, opium eating is much more common than opium smoking. While it has been claimed that a large proportion of the people of India use the drug without harm through life, and that they, in contradistinction to the European races, suffer little danger of accumulative action or the establishment of a craving. Of recent years, however, the habitual use of opium in any form is more and more admitted to tend both to moral and physical degeneration.

Opium smoking, while preeminently a Chinese vice, has been practiced by lower classes of whites, Negroes, and Malays, being usually communicated to them more or less directly through the Chinese. Chinese smoking opium, or chandoo, is prepared wholly from low-grade opium, that containing a higher percentage—9 per cent or more—being unacceptable for this purpose. Smoking opium is made by a cooking process, in which the raw opium is somewhat concentrated, with a consequent raising of the alkaloid content. The ashes or "dirt" left after smoking are made into a cheaper mixture for smoking; the alkaloid content is comparatively high. It has been shown by analysis that only a small proportion of the morphine present is volatilized or otherwise removed in the smoke, and it is believed that the physiological effect of smoking is due rather to products of combustion of morphine and other alkaloids rather than to the alkaloids themselves.

As a drug, opium is official in all pharmacopœias. Its American official forms and preparations include deodorized opium, granulated opium, powdered opium, opium and ipecac powder (Dover s powder), tincture of opium (laudanum), camphorated tincture of opium (paregoric), tincture of deodorized opium, compound liniment of opium, extract of opium, morphine and its hydrochlorid and sulphate, and codeine and its phosphate.

The therapeutic action of opium is chiefly due to, and for the most part identical with, that of morphine (which see). It is narcotic, sedative, anodyne, antispasmodic, hypnotic, and diaphoretic. It relieves all pain by directly benumbing the perceptive centers in the brain and by allaying irritation and spasm. Aside from the anesthetics it is the most powerful pain-relieving drug known. It will always produce sleep if given in large enough dose. Its chief uses are to relieve pain from any cause save acute inflammation of the brain,

to produce sleep, to allay irritation in certain nervous diseases, to check excessive secretion, as in diarrhea, dysentery, etc., to support the system in low fevers, and to produce sweating in coryza and similar affections. For most purposes it may advantageously be replaced by morphine. Children are particularly susceptible to the poisonous actions of opium, and it is, or should be, rarely prescribed for them.

The alkaloids of opium are some 25 in number; the most important are discussed under "Derivatives of opium." It is estimated that 75 per cent or more of opium imported into the United States is used in manufacture of morphine.

Opium, or more particularly its derivatives, is a frequent ingredient of proprietaries, especially of the "soothing-sirup" and "pain-killer" types. Its abuse in this connection is largely responsible for the restrictions imposed on its use by the Federal food and drugs act, the Harrison Narcotic Act, and various State enactments based upon these; and the enforcement of these laws has diminished considerably the use of opium and its derivatives in secret remedies.

The chief uses of opium, as has been said, are as a hypnotic, to produce sleep, and, as an analgesic, to relieve pain. The class of hypnotics includes also paraldehyde; chloral hydrate and its derivatives, of which chloralamid, isopral, and chloretone may be mentioned; the sulphones, embracing sulphonal, trional, and tetronal; ethyl carbonate or urethane; veronal; bromural; the bromides; and cannabis indica. Of analgesics may be mentioned cannabis indica, and the coal-tar analgesics, including acetanilid, acetphenetidin or phenacetin, and antipyrine.

In some other members of the poppy family (*Papaveraceæ*) are found alkaloids closely resembling those of opium. These plants include *Chelidomim majus* (celandine) and *Sanguinaria canadensis* (bloodroot). The alkaloids, however, occur only in small proportions, and are at the present time of no commercial importance.

The genus Anhalonium (Cactaceæ) includes a number of alkaloids, of which some resemble morphine. The chief representative of this genus is the mescal, of the Southwest and Mexico, which has attained some notoriety as a narcotic stimulant whose use is spreading among the Indians.

The ultimate consequences of all forms of habitual opium consumption are largely identical, although great individual differences in susceptibility exist. Opium smoking induces a form of intoxication accompanied by sharpened imagination, sensations of pleasure, a feeling of energy strangely mingled with lethargy. The after effect is depression and sensations similar to those following an alcoholic debauch, but worse, which usually incite a return to the drug. Opium in any of its forms taken orally or hypodermically affects the imagination much less. Morphinism, because of the frequent use of the alkaloid, is the chief present-day form of opiumism. The habit is almost invariably the result of medication; when the narcotic effect is passed, the pain or disorder returns, and may only be allayed by another dose. The systemic consequences of the habit are disturbances of the digestive tract, loss of flesh, a peculiar diseased appearance of the skin, irregularity of the heart, nervous tremors, irritability. Powers of resistance are broken down, and death frequently ensues from some trifling ailment. The character of the

addict soon sinks to the lowest level; with a certain amount of low cunning he combines unscrupulousness; he becomes untruthful, dishonest, incapable of any effort save to get his drug, and capable of any crime for this purpose. Withdrawal of the drug leads to so-called abstinence symptoms, of which the chief feature is an uncontrollable craving for the drug, culminating in hysteria and even mania. The use of cocaine as a stimulant and counteractive leads to an even worse habit, and generally ends in an addiction to both drugs. The opium habit in children is not at all rare, and is usually started by the use of paregoric and soothing sirups. The opium habit is almost ineradicable, and may be treated with hope of success only when the patient is under restraint, as in a specialized institution. The methods used in many "drug-cure" establishments result only in completing the ruin begun by the drug. Several of the chief medical societies of the country have gone on record that the habit, once firmly established, is absolutely incurable, and have favored prohibition of the manufacture of heroin as the most insidious drug of its class, whose abuse is most rapidly spreading.

WAR DISTURBANCES.

Probably no other important crude drug was more radically affected by the war than opium. The Turkish supply was virtually cut off when Turkey entered the war. Persian opium has furnished the chief supply, but the crops have been scanty and the drug has suffered from the acute shortage of shipping and from various embargoes. Furthermore, it has been in great demand for Army requirements, and our main sources of supply have been through England, whose domestic demand for opium for war purposes has apparently led to some restriction of shipments.

No unusual sources of opium due to the war have yet become of much commercial importance. The opium crop of Greek Macedonia—30 to 100 cases annually—has attracted considerable attention. It is marketed mainly via Saloniki. No imports of opium from Greece were noted prior to 1915; in 1916 they ranked second only to England's. Indian opium has been used to a considerable extent by British manufacturers, and some may have reached this country via England, but its low morphine content bars all but exceptional samples from America. Trade journals report considerable activity in opium production in Japan and Formosa; this is in line with the recent activity of the Japanese in drug and chemical lines. The increasing stringency of Chinese laws against opium production render it highly improbable that this country will be, in the near future at least, a source of opium. Several other countries are experimenting in production. Nothing which has attracted attention has been done in America.

Foreign buyers have been active in the American opium market, and our own Army requirements have been large. The enforcement of the Harrison narcotic law and various State enactments has doubtless lessened the domestic demand, but, in contrast with the decreased supply and other large requirements noted, has had no effect on prices. Prior to the outbreak of the World War opium sold at $7.45 per pound in the New York market; in 1916 it reached $11 and $30 in 1917, being largely nominal much of the time.

Smoking opium siezed at the ports, and other opium imported contrary to law, is now sequestered for Government use instead of being destroyed as formerly. It is presumably used for the extraction of morphine.

Opium—Exports from British India.

[Source: Tables Relating to the Trade of British India with the British Empire and Foreign Countries, 1912-13 to 1916-17, p. 127.]

Countries.	1909-10		1910-11		1911-12	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Hongkong	4,951,072	$16,435,251	3,313,968	$19,287,224	1,190,160	$14,606,139
Straits Settlements	1,829,856	6,008,974	1,501,024	8,234,376	1,097,040	5,352,182
China	1,553,776	6,007,363	1,676,640	10,724,160	1,919,904	17,591,847
All other	587,104	1,765,021	567,728	3,164,826	1,002,736	4,825,203
Total	8,921,808	30,216,609	7,059,360	41,410,586	5,929,840	42,465,371

Countries.	1912-13		1913-14		1914-15	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Hongkong	1,214,528	$11,709,208	562,576	$5,275,739	164,192	$538,780
Straits Settlements	836,976	3,430,250	252,560	1,102,262	123,984	392,104
China	1,445,360	15,781,607	12,492	135,449	.....	.....
All other	1,375,696	5,485,650	1,060,528	4,582,321	1,493,968	4,790,363
Total	4,872,560	36,406,715	1,888,096	11,095,771	1,782 144	5,721,247

Countries.	1915-16		1916-17		1917-18		1918-19	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
Hongkong	120,400	$385,208	72,800	$234,945	73,920	$377,485	89,712	$552,332
Straits Settlements	99,344	330,026	39,312	191,750	63,280	402,972	24,864	161,260
Indo-China	.....	.....	.....	.....	600,752	3,043,480	564,704	3,718,587
All other	1,222,592	4,054,534	1,317,008	6,375,115	672,212	3,967,091	1,039,360	569,286
Total	1,442,336	4,769,768	1,429,120	6,801,810	1,380,064	7,791,028	1,718,640	10,126,165

Opium—Imports into the United Kingdom[1] *(fiscal years).*

Imported from—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
European Turkey	197,334	$644,047	144,765	$657,264	125,406	$636,032
Asiatic Turkey	242,406	775,521	155,185	676,838	109,570	591,484
Persia	166,820	603,986	136,591	548,776	254,078	1,416,964
Hongkong	1,400	6,131	18,652	82,726	49,503	276,213
All other	23,209	82,687	8,323	38,304	17,074	84,108
Total	631,169	2,112,372	463,516	2,003,908	555,631	3,004,801

[1] Annual Statement of Trade of the United Kingdom, 1914, p. 107; 1918, p. 107.

Opium—Imports into the United Kingdom (fiscal years)—Continued.

Imported from—	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
European Turkey	155,377	$651,420	152,564	$616,041	192,618	$1,170,442
Asiatic Turkey	217,216	851,044	391,289	1,177,912	21,671	106,007
Persia	136,464	695,189	260,999	1,294,284	492,894	2,417,940
Hongkong	38,000	185,423	29,960	128,602	13,720	68,223
All other	19,777	85,514	115,408	458,224	230,810	1,204,489
Total	566,834	2,468,590	860,220	3,585,063	951,713	4,967,101

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
European Turkey	27,651	$219,430	7,660	$62,535	.....	.....
Asiatic Turkey	1,760	14,600	13,760	122,222	560	$7,640
Persia	193,283	1,109,810	207,802	1,997,931	48,649	637,512
Hongkong	8,058	43,716	4,035	19,290	.....	.....
All other	464,128	1,791,407	585,834	2,240,182	390,720	1,456,101
Total	694,880	3,178,963	819,091	4,352,160	439,929	2,101,253

Opium—Exports from England [1] *(fiscal years).*

Exported to—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	24,635	$95,452	29,365	$124,295	16,377	$75,840
Netherlands	13,648	51,877	32,541	138,686	34,087	213,070
Japan	.....	.....	.....	.....	10,539	53,240
United States	15,576	53,833	44,403	165,062	16,929	108,722
All other	138,410	552,002	94,959	469,038	85,523	459,344
Total	192,269	753,164	201,268	897,081	163,455	910,216

Exported to—	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	12,528	$59,143	33,520	$161,894	.....	.....
Netherlands	61,809	306,648	44,137	181,272	334	$2,097
Japan	23,879	122,096	49,438	237,232	71,003	385,208
United States	25,795	121,273	42,583	193,122	53,696	253,754
All other	157,503	779,846	81,847	387,228	43,539	239,354
Total	281,514	1,389,006	251,525	1,160,748	168,572	880,413

Exported to—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	.....	.....	.....	.....	.....	.....
Netherlands	222	$1,406	44	$364	.....	.....
Japan	71,578	422,427	2,760	28,723	6,760	$98,741
United States	29,240	171,593	87,757	960,827	39,411	567,103
All other	33,161	205,697	34,675	272,991	34,401	503,011
Total	134,201	801,123	125,236	1,262,905	80,572	1,168,855

[1] Annual Statement of Trade of the United Kingdom, 1914, p. 542; 1918, p. 553.

IMPORTS INTO THE UNITED STATES.

Opium, crude, containing 9 per cent and over of morphia—Imports by countries (fiscal years).

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
England	217,315	$872,129	48,409	$191,144	110,589	$411,935
Turkey in Asia	173,533	616,098	135,957	488,096	239,568	832,277
Turkey in Europe	98,304	373,416	222,950	790,139	225,598	774,642
Italy	750	2,290	3,185	10,100	.....	.....
France	58	173	32	71	.....	.....
Cuba	5	10	.....	.....	.....	.....
Germany	21,624	64,473	38,706	142,925	54,087	189,591
All other	[1] 5,799	[1] 22,929	.....	.....	.....	.....
Total	517,388	1,951,518	449,239	1,622,475	629,842	2,208,445

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
United Kingdom	82,782	$651,567	61,782	$356,971	39,372	$161,736
Turkey in Asia	132,826	762,745	210,993	1,090,880	222,975	885,517
Turkey in Europe	141,886	797,646	209,413	964,484	160,514	614,838
Germany	42,343	225,445	26,245	153,630	32,339	148,338
Total	399,837	2,437,403	508,433	2,565,965	455,200	1,810,429

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
England	38,258	$234,828	62,665	$410,882	65,356	$622,363
Greece	2,940	13,460	46,367	274,576	6,138	55,621
Turkey in Asia	212,367	976,234	14,239	54,928	.....	.....
Turkey in Europe	228,162	1,208,767	13,644	64,380	599	4,758
Portugal	.....	.....	4,500	34,166	.....	.....
Italy	2,268	11,631	2,291	18,076	4,285	123,472
France	.....	.....	1,711	15,811	.....	.....
Persia	.....	.....	1,216	6,555	10,257	35,684
Cuba	.....	.....	25	325	.....	.....
Germany	32	85	.....	.....	.....	.....
Canada	.....	.....	.....	.....	177	1,520
Total	484,027	2,445,005	146,658	879,699	86,812	843,418

Imported from—	1918		1919[2]		1920[3]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
England	126,173	$1,951,732	40,207	$588,828	.....	.....
Greece	27,087	422,658	45,521	342,918	.....	.....
Turkey in Asia	.....	.....	318,718	3,564,679	.....	.....
Turkey in Europe	.....	.....	322,469	3,750,477	.....	.....
Portugal	.....	.....	.....	.....	.....	.....
Italy	815	42,470	.....	.....	.....	.....
France	1	16	2,577	30,865	.....	.....
Persia	3,758	26,352	780	1,886	.....	.....
Cuba	.....	.....	.....	.....	.....	.....
Germany	.....	.....	.....	.....	.....	.....
All other	.....	.....	.....	.....	.....	.....
Total	157,834	2,443,228	730,272	8,279,653	201,083	$1,275,751

[1] British India. [2] Calendar year. [3] Ten months ending Oct. 31, 1920.

Opium, containing less than 9 per cent of morphia—Imports by countries (fiscal years).

Imported from—	1909	
	Pounds.	Value.
Chinese Empire	90,009	$825,767
Canada	1,084	10,117
Hongkong	960	7,177
All other		
Total	92,053	843,061

Opium and manufactures of, prepared for smoking, containing less than 9 per cent of morphia (act of 1897)[1]—Imports for consumption—Revenue.

Fiscal years.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	$6 per pound	147,624	$1,382,095	$885,744	$9.36	64.09
1909	do	118,508	1,072,591	711,052	9.05	66.29

[1] Under act of Feb. 9, 1909, effective Apr. 1, 1909, the importation of opium prepared for smoking was prohibited.

Opium and manufactures of, crude or unmanufactured and not adulterated, containing 9 per cent and over of morphia—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				*Per cent.*
1908	$1 per pound	320,415	$1,182,739	$320,415	$3.69	27.08
1909	do	465,776	1,831,679	465,776	3.93	25.43
1909[1]	$1 per pound less 20 per cent.	5	10	4	2.00	40.00
1910[2]	$1 per pound	44,195	146,932	44,195	3.32	30.08
1910[3]	$1.50 per pound	367,249	1,306,240	550,873	3.56	42.17
1911	do	502,407	1,644,301	753,610	3.27	45.83
1912	do	384,911	2,020,026	577,367	5.25	28.58
1913	do	441,276	2,130,154	661,914	4.83	31.07
1914[4]	do	276,985	1,087,236	415,477	3.93	38.21
1914[5]	$3 per pound	164,636	644,353	493,908	3.91	76.65
1915	do	353,006	1,699,217	1,059,013	4.81	62.32
1916	do	117,870	535,183	353,610	4.54	66.07
1917	do	43,016	330,652	129,048	7.68	39.03
1918	do	21,342	265,283	64,026	12.43	24.13
1919	do	74,264	977,596	222,792	13.16	22.79
Calendar year—						
1918	do	15,254	240,738	45,762	15.78	19.01
1919	do	316,713	3,818,725	950,139	12.06	24.88
1920[6]	do	168,004	1,516,916	504,012	9.02	33.22

[1] From Cuba (reciprocity treaty Dec. 27, 1903).
[2] Act of 1897, July 1 to Aug. 5, 1909.
[3] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[4] Act of 1909, July 1 to Oct. 3, 1913.
[5] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[6] Six months ended June 30, 1920.

Opium and manufactures of, dried, powdered, or otherwise advanced, containing 9 per cent and over of morphia (acts of 1909 and 1913)[1]*—Imports for consumption—Revenue.*

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				*Per cent.*
1910	$2 per pound	27,934	$128,000	$55,869	$4.58	43.65
1911	do	67,962	304,200	135,925	4.48	44.68
1912	do	77,551	641,887	155,102	8.28	24.16
1913	do	49,070	389,364	98,141	7.94	25.17
1914[2]	do	4,321	28,061	8,643	6.49	30.80
1914[3]	$4 per pound	27,773	177,623	111,094	6.40	62.54
1915	do	38,977	308,928	155,908	7.92	50.47
1916	do	44,052	243,790	176,208	5.53	72.28
1917	do	77,990	640,563	311,960	8.21	48.70
1918	do	98,498	1,514,127	393,992	15.37	26.02
1919	do	101,989	1,776,787	407,956	17.42	22.96
Calendar year—						
1918	do	137,713	2,337,278	550,852	16.24	23.57
1919	do	27,702	505,408	110,808	18.24	21.92
1920[4]	do	1,376	5,757	5,504	4.18	95.60

[1] Act of 1913 specified "dried to contain 15 per cent or less of moisture, powdered or otherwise advanced."
[2] Act of 1909, July 1 to Oct. 3, 1913.
[3] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[4] Six months ended June 30, 1920.

Opium, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

GRANULAR.		POWDERED.	
Jan. 1, 1912	$9.75–$10.00	Jan. 1, 1912	$9.75–$10.00
Apr. 1, 1912	9.40– 9.50	Apr. 1, 1912	9.40– 9.50
July 1, 1912	8.00– 8.15	July 1, 1912	8.00– 8.15
Sept. 30, 1912	8.25– 8.35	Sept. 30, 1912	7.85– 8.00
Dec. 30, 1912	7.75– 7.85	Dec. 30, 1912	7.75– 7.85
Mar. 31, 1913	7.50– 7.60	Mar. 31, 1913	7.40– 7.50
June 30, 1913	7.90– 8.00	June 30, 1913	7.75– 7.80
Sept. 29, 1913	7.25– 7.40	Sept. 29, 1913	7.25– 7.40
Dec. 29, 1913	7.45– 7.55	Dec. 29, 1913	7.35– 7.45
Mar. 30, 1914	7.75– 7.80	Mar. 30, 1914	7.65– 7.70
June 29, 1914	7.95– 8.00	June 29, 1914	7.85– 7.90
Sept. 28, 1914	13.00	Sept. 28, 1914	12.00
Dec. 28, 1914	11.50	Dec. 28, 1914	11.00
Mar. 29, 1915	8.90– 9.10	Mar. 29, 1915	8.75– 8.90
June 28, 1915	8.35– 8.40	June 28, 1915	8.25– 8.30
Sept. 27, 1915	9.35– 9.50	Sept. 27, 1915	9.25– 9.30
Jan. 3, 1916	12.50– 12.60	Jan. 3, 1916	12.25– 12.30
Apr. 3, 1916	13.00– 13.10	Apr. 3, 1916	13.00– 13.10
July 3, 1916	12.50	July 3, 1916	12.50
Oct. 2, 1916	11.85	Oct. 2, 1916	11.70
Jan. 1, 1917	14.50	Jan. 1, 1917	14.50
Apr. 2, 1917	[1] 25.00– 30.00	Apr. 2, 1917	[1] 25.00– 30.00
July 2, 1917	31.00	July 2, 1917	29.00
Oct. 1, 1917	(1)	Oct. 1, 1917	(1)
Dec. 31, 1917	32.00– 35.00	Dec. 31, 1917	32.00– 35.00
Jan. 5, 1918	32.00– 35.00	Jan. 5, 1918	32.00– 35.00
Apr. 1, 1918	27.00	Apr. 1, 1918	27.00
July 1, 1918	25.00	July 1, 1918	24.50
Oct. 7, 1918	24.50	Oct. 7, 1918	23.50
Jan. 6, 1919	25.50	Jan. 6, 1919	24.50
Apr. 7, 1919	23.50	Apr. 7, 1919	22.50
July 7, 1919	14.00	July 7, 1919	11.00
Oct. 6, 1919	9.25	Oct. 6, 1919	9.25
Jan. 1920	8.50	January, 1920	8.50
Apr. 1920	8.00	April, 1920	8.00
July, 1920	8.50	July, 1920	8.50
October, 1920	8.50	October, 1920	8.50

[1] Nominal.

Opium, prices per pound, wholesale, New York, spot—Continued.

JOBBING LOTS.

Jan. 1, 1912	$8.55– $8.60	Oct. 2, 1916	$11.05
Apr. 1, 1912	7.75– 7.80	Jan. 1, 1917	13.55
July 1, 1912	6.35– 6.50	Apr. 2, 1917	[1] $20.00– 25.00
Sept. 30, 1912	7.15– 7.20	July 2, 1917	28.00
Dec. 30, 1912	6.60– 6.65	Oct. 1, 1917	[1]
Mar. 31, 1913	6.20– 6.25	Dec. 31, 1917	[1] 30.00– 35.00
June 30, 1913	6.05– 6.15	Jan. 5, 1918	30.00– 35.00
Sept. 29, 1913	5.80– 5.95	Apr. 1, 1918	[1] 25.00
Dec. 29, 1913	6.05– 6.15	July 1, 1918	23.00
Mar. 30, 1914	6.45– 6.50	Oct. 7, 1918	21.50
June 29, 1914	6.90– 6.95	Jan. 6, 1919	22.50
Sept. 28, 1914	10.00– 12.00	Apr. 7, 1919	.....
Dec. 28, 1914	9.05	July 7, 1919	.....
Mar. 29, 1915	7.55– 7.70	Oct. 6, 1919	.....
June 28, 1915	7.05– 7.30	January, 1920	.....
Sept. 27, 1915	8.30– 8.35	April, 1920	.....
Jan. 3, 1916	11.05– 11.30	July, 1920	.....
Apr. 3, 1916	11.55– 11.65	October, 1920	.....
July 3, 1916	11.45		

[1] Nominal.

U. S. P.

Jan. 1, 1912	[1] $8.50– $8.60	Oct. 2, 1916	[1] $11.00
Apr. 1, 1912	[1] 7.50– 7.75	Jan. 1, 1917	13.50
July 1, 1912	[1] 6.50– 7.15	Apr. 2, 1917	[2] $20.00– 25.00
Sept. 30, 1912	[1] 7.20– 6.60	July 2, 1917	27.00
Dec. 30, 1912	[1] 6.60– 6.65	Oct. 1, 1917	[3] 30.00– 35.00
Mar. 31, 1913	6.15– 6.20	Dec. 31, 1917	[1] 30.00– 35.00
June 30, 1913	6.00– 6.10	Jan. 5, 1918	[2] 30.00– 35.00
Sept. 29, 1913	[1] 5.75– 5.90	Apr. 1, 1918	[2] 25.00
Dec. 29, 1913	[1] 6.00– 6.10	July 1, 1918	23.00
Mar. 31, 1914	[1] 6.40– 6.45	Oct. 7, 1918	21.50
June 29, 1914	[1] 6.85– 6.90	Jan. 6, 1919	22.50
Sept. 28, 1914	[1]	Apr. 7, 1919	6.00– 8.00
Dec. 28, 1914	[1] 9.00	July 7, 1919	8.00– 9.00
Mar. 29, 1915	7.50– 7.65	Oct. 6, 1919	7.00– 8.25
June 28, 1915	[1] 7.00– 7.25	January, 1920	6.75– 7.50
Sept. 27, 1915	[1] 8.25– 8.30	April, 1920	6.25– 6.50
Jan. 3, 1916	[1] 11.00– 11.25	July, 1920	7.50
Apr. 3, 1916	[1] 11.50– 11.60	October, 1920	7.50
July 3, 1916	[1] 11.40		

[1] "U. S. P." omitted. [2] Nominal. [3] Nominal, as no shipments arrived during this week.

PERSIAN GUM.

Dec. 31, 1917	[1] $30.00	July, 1919	.....
Jan. 5, 1918	[1] 30.00	Oct. 6, 1919	.....
April, 1918	.....	January, 1920	.....
July, 1918	.....	April, 1920	.....
October, 1918	.....	July, 1920	.....
Jan. 6, 1919	.....	October, 1920	.....
April, 1919	.....		

[1] Nominal.

Opium—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	120	Opium, crude, containing 9 per cent and over of morphia. The importation of opium containing less than 9 per cent morphia is hereby prohibited.	$1 per pound.
	121	Opium, prepared for smoking and all other preparations of opium not specially enumerated or provided for in this act. But opium prepared for smoking and other preparations of opium deposited in bonded warehouses shall not be removed therefrom for exportation without payment of duties, and such duties shall not be refunded.	$10 per pound.
1890	48	Opium containing less than 9 per cent of morphia, and opium prepared for smoking. But opium prepared for smoking and other preparations of opium deposited in bonded warehouses shall not be removed therefrom without payment of duties, and such duties shall not be refunded.	$12 per pound.
	663	Opium, crude or unmanufactured, and not adulterated, containing 9 per cent and over of morphia.	Free.

Opium—Rates of duty—Continued.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1894	36	Opium containing less than 9 per cent of morphia, and opium prepared for smoking. But opium prepared for smoking and other preparations of opium deposited in bonded warehouses shall not be removed therefrom without payment of duties, and such duties shall not be refunded.	$6 per pound.
	663	Opium, crude or unmanufactured, and not adulterated, containing 9 per cent and over of morphia.	Free.
1897	43	Opium, crude or unmanufactured, and not adulterated, containing 9 per cent and over of morphia.	$1 per pound.
		* * * opium containing less than 9 per cent of morphia, and opium prepared for smoking. But opium prepared for smoking and other preparations of opium deposited in bonded warehouses shall not be removed therefrom without payment of duties, and such duties shall not be refunded.	$6 per pound.
1909	41	Opium, crude or unmanufactured, and not adulterated, containing 9 per cent and over of morphia.	$1.50 per pound.
		* * * opium of the same composition, dried, powdered, or otherwise advanced beyond the condition of crude or unmanufactured.	$2 per pound.
		* * * opium containing less than 9 per cent of morphia..... But preparations of opium deposited in bonded warehouses shall not be removed therefrom without payment of duties, and such duties shall not be refunded: *Provided*, That nothing herein contained shall be so construed as to repeal or in any manner impair or affect the provisions of an act entitled "An act to prohibit the importation and use of opium for other than medicinal purposes," approved February 9, 1909.	$6 per pound.
1913	47	Opium, crude or unmanufactured, and not adulterated, containing 9 per cent and over of morphia.	$3 per pound.
		* * * opium of the same composition, dried to contain 15 per cent or less of moisture, powdered, or otherwise advanced beyond the condition of crude or unmanufactured.	$4 per pound.
		* * * opium containing less than 9 per cent of morphia..... But preparations of opium deposited in bonded warehouses shall not be removed therefrom without payment of duties, and such duties shall not be refunded: *Provided*, That nothing herein contained shall be so construed as to repeal or in any manner impair or affect the provisions of an act entitled "An act to prohibit the importation and use of opium for other than medicinal purposes," approved Feb. 9, 1909.	$6 per pound.

ACT PROHIBITING IMPORTATION OF OPIUM AND COCAINE.

[PUBLIC NO. 46—63D CONG.—H. R. 1966.]

AN ACT To amend an act entitled "An Act to prohibit the importation and use of opium for other than medicinal purposes," approved February ninth, nineteen hundred and nine.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That an Act entitled "An Act to prohibit the importation and use of opium for other than medicinal purposes," approved February ninth, nineteen hundred and nine, is hereby amended so as to read as follows:

"That after the first day of April, nineteen hundred and nine, it shall be unlawful to import into the United States opium in any form or any preparation or derivative thereof: *Provided*, That opium and preparations and derivatives thereof, other than smoking opium or opium prepared for smoking, may be imported for medicinal purposes only, under regulations which the Secretary of the Treasury is hereby authorized to prescribe, and when so imported shall be subject to the duties which are now or may hereafter be imposed by law.

"SEC. 2. That if any person shall fraudulently or knowingly import or bring into the United States, or assist in so doing, any opium or any preparation or derivative thereof contrary to law, or shall receive, conceal, buy, sell, or in any manner facilitate the transportation, concealment, or sale of such opium or preparation or derivative thereof after importation, knowing the same to have been imported contrary to law, such opium or preparation or derivative thereof shall be forfeited and shall be destroyed, and the offender shall be fined in any sum not exceeding $5,000 nor less than $50 or by imprisonment for any time not exceeding two years, or both. Whenever, on trial for a violation of this section, the defendant is shown to have, or to have had, possession of such opium or preparation or derivative thereof, such possession shall be

deemed sufficient evidence to authorize conviction unless the defendant shall explain the possession to the satisfaction of the jury.

"SEC. 3. That on and after July first, nineteen hundred and thirteen, all smoking opium or opium prepared for smoking found within the United States shall be presumed to have been imported after the first day of April, nineteen hundred and nine, and the burden of proof shall be on the claimant or the accused to rebut such presumption.

"SEC. 4. That any person subject to the jurisdiction of the United States who shall, either as principal or as accessory, receive or have in his possession, or conceal on board of or transport on any foreign or domestic vessel or other water craft or railroad car or other vehicle destined to or bound from the United States or any possession thereof, any smoking opium or opium prepared for smoking, or who, having knowledge of the presence in or on any such vessel, water craft, or vehicle of such article, shall not report the same to the principal officer thereof, shall be subject to the penalty provided in section two of this Act. Whenever on trial for violation of this section the defendant is shown to have or to have had possession of such opium, such possession shall be deemed sufficient evidence to authorize conviction, unless the defendant shall explain the possession to the satisfaction of the jury: *Provided, however*, That any master of a vessel or other water craft, or person in charge of a railroad car or other vehicle, shall not be liable under this section if he shall satisfy the jury that he had no knowledge and used due diligence to prevent the presence of such article in or on such vessel, water craft, car, or other vessel, and any such article shall be forfeited and shall be destroyed.

"SEC. 5. That no smoking opium or opium prepared for smoking shall be admitted into the United States, or into any territory under the control or jurisdiction thereof, for transportation to another country, nor shall such opium be transferred or transshipped from one vessel to another vessel within any waters of the United States for immediate exportation or any other purpose.

"SEC. 6. That hereafter it shall be unlawful for any person subject to the jurisdiction of the United States to export or cause to be exported from the United States, or from territory under its control or jurisdiction, or from countries in which the United States exercises extraterritorial jurisdiction, any opium or cocaine, or any salt, derivative, or preparation of opium or cocaine, to any other country: *Provided*, That opium or cocaine, and salts, derivatives, or preparations thereof, except smoking opium or opium prepared for smoking, the exportation of which is hereby absolutely prohibited, may be exported to countries regulating their entry under such regulations as are prescribed by such country for the importation thereof into such country, such regulations to be promulgated from time to time by the Secretary of State of the United States.

"The Secretary of State shall request all foreign Governments to communicate through the diplomatic channels copies of laws and regulations promulgated in their respective countries which prohibit or regulate the importation of the aforesaid drugs, and when received advise the Secretary of the Treasury and the Secretary of Commerce thereof; whereupon the Secretary of State, the Secretary of the Treasury, and the Secretary of Commerce shall make and publish all proper regulations for carrying the provisions of this section into effect.

"SEC. 7. That any person who exports or causes to be exported any of the aforesaid drugs in violation of the preceding section shall be fined in any sum not exceeding $5,000 nor less than $50, or by imprisonment for any time not exceeding two years, or both. And one-half of any fine recovered from any person or persons convicted of an offense under any section of this Act may be paid to the person or persons giving information leading to such recovery, and one-half of any bail forfeited and collected in any proceedings brought under this Act may be paid to the person or persons giving the information which led to the institution of such proceedings, if so directed by the court exercising jurisdiction in the case: *Provided*, That no payment for giving information shall be made to any officer or employee of the United States.

"SEC. 8. That whenever opium or cocaine or any preparations or derivatives thereof shall be found upon any vessel arriving at any port of the United States which is not shown upon the vessel's manifest, as is provided by sections twenty-eight hundred and six and twenty-eight hundred and seven of the Revised Statutes, such vessel shall be liable for the penalty and forfeiture prescribed in section twenty-eight hundred and nine of the Revised Statutes."

Approved, January 17, 1914. (T. D. 34221.) (See T. D. 36418 and 36552 concerning expenses of shipments of samples and of expert witnesses; also T. D. 34452 upon rewards to informers.)

Opium and Cocaine.

[Regulations under act of Jan. 17, 1914.]

DEFINITIONS.

1. The term "opium" shall cover all forms of opium known to the trade, such as gum opium, powdered opium, denarcotized opium, granular opium, smoking opium, cooked opium, etc. The terms "smoking opium" and "opium prepared for smoking" have one and the same meaning.

2. The term "preparation" shall mean any product, mixture, or compound containing or representing opium.

3. The term "derivative" shall include the following alkaloids, their salts or combinations, obtained either directly or indirectly, and such other derivatives obtained from opium as it may be found necessary to include in the future: Morphine, codeine, dionin, diacetyl morphine, heroin, peronine, their chlorides, sulphates, phosphates, etc., and all mixtures, compounds, or preparations containing any of the foregoing.

4. The term "for medicinal purposes only" shall mean the use of opium or preparations or derivatives thereof for the treatment, mitigation, or prevention of disease of man or other animal.

SEIZURE AND DESTRUCTION OF SMOKING OPIUM.

5. Collectors shall seize forthwith, as an illegal importation, smoking opium or opium prepared for smoking, and destroy the same summarily without judicial proceedings.

DELIVERY OF OPIUM OTHER THAN SMOKING OPIUM.

6. Collectors shall permit the delivery of opium (other than smoking opium), or preparations or derivatives of opium, only when imported for medicinal purposes.

ENTRY AND DELIVERY OF OPIUM, PREPARATIONS AND DERIVATIVES THEREOF.

7. Entries of opium (other than smoking opium) and preparations and derivatives thereof imported for medicinal purposes will be permitted for consumption or warehouse at the following-named ports only: Baltimore, Boston, Chicago, Detroit, Honolulu, New Orleans, New York, Philadelphia, San Juan, San Francisco, Seattle, and St. Louis. Entries, however, may be made for immediate transportation in bond without appraisement to any of the said ports. Upon entry the merchandise shall be detained by the collector until the regulations herein shall have been complied with and delivery shall be made only in accordance with these regulations. The collector shall in no case permit delivery unless satisfied that the importations are for medicinal purposes only. If not so satisfied, he shall seize the articles and report the facts to the United States attorney.

DECLARATION OF OWNER OR ULTIMATE CONSIGNEE.

8. Upon every importation of crude or unmanufactured opium and the preparations and derivatives thereof, there shall be filed with the collector at the time of entry a declaration of the owner or ultimate consignee of the merchandise, in the following form:

"I, ——— ——— (name of representative), of the ——— (name of firm or corporation), manufacturing chemists or dealers in drugs, do solemnly and truly declare that the —— (number) cases or packages of opium, preparations or derivatives thereof, more particularly described in the invoice and entry herewith submitted and imported at ——— (port) per ——— (steamship), on the —— day of ———, 191–, are expressly imported and are intended in good faith to be used by ——— (name of firm or corporation) in the preparation of medicines or are to be sold by ——— (name of firm or corporation) for medicinal purposes only, and such opium, preparations or derivatives thereof, are not intended to be used for smoking."

ENTIRE IMPORTATION TO BE ORDERED INTO APPRAISER'S WAREHOUSE.

9. The collector shall order the entire number of packages of opium or preparations or derivatives thereof into the appraiser's warehouse for examination.

MINIMUM QUANTITIES PERMITTED DELIVERY ESTABLISHED.

10. The collector shall permit no delivery of crude or unmanufactured opium in quantities or packages containing less than 100 pounds; nor of morphine or its salts, either singly or assorted, in quantities or packages containing less than 50 ounces; nor of codeine, heroin, dionin, diacetyl morphine, their salts, or any other derivative of opium or its salts not otherwise provided for, either singly or assorted, in quantities or packages containing less than 25 ounces, and then only upon the report of the appraiser as to their quality, purity, and fitness for medicinal purposes and upon compliance with the existing laws and regulations governing the importation of drugs and medicines: *Provided, however,* That special preparations, rarely imported and usually imported in very small quantities and not known to be used by drug habitues, like papaverine and thebaine, may be imported in smaller quantities by well-known and reputable firms or institutions upon compliance with these regulations.

DUTIES ON OPIUM, ETC., DEPOSITED IN BONDED WAREHOUSE.

11. Opium containing less than 9 per cent of morphia and preparations or derivatives of opium deposited in bonded warehouses shall not be removed therefrom without payment of duties and such duties shall not be refunded.

IMPORTERS' RECORD OF SALES.

12. Importers shall keep a record of all sales of imported opium and derivatives or preparations of opium or of articles manufactured by them therefrom, showing the names of purchasers, their place of business, date of sale, and the name and quantity of the article sold, which record shall be open to the inspection of the proper customs officers.

PROHIBITION OF TRANSFER OR TRANSSHIPMENT OF SMOKING OPIUM.

13. Collectors are cautioned to observe strictly the prohibition, contained in section 5 of the act, of the admission of smoking opium for transportation to any country or the transfer or transshipment of such opium from one vessel to another vessel within any waters of the United States for any purpose.

PENALTY FOR FAILURE TO MANIFEST OPIUM, ETC.

14. Attention is invited to the provision in section 8 of the act that the *vessel* shall be liable for the penalty and forfeiture prescribed in section 2809, Revised Statutes, when any opium or cocaine or any preparations or derivatives thereof which may be found on a vessel are not shown on the manifest. Subject to this provision, the procedure prescribed in T. D. 32083 of December 14, 1911, will continue in force.

EXPORTS.

15. Pending the promulgation of regulations governing the exportation of opium, cocaine, and derivatives and preparations thereof, collectors of customs will not permit the exportation of any of the articles mentioned in paragraph 6 of the act without express authority in each case.

MAIL IMPORTATIONS.

16. The provisions of article 830, Customs Regulations of 1908, relative to articles prohibited importation in the mails are hereby extended, so far as applicable, to articles which are the subject of the act appended hereto.

VIOLATIONS TO BE REPORTED.

17. Collectors shall report to the department and to the United States attorney any violations of the act which shall come to their knowledge.—Dept. Order (T. D. 34221).

COURT AND TREASURY DECISIONS.

Under authority of section 3018, Revised Statutes, and article 680 of the Customs Regulations of 1884, allowing the repacking for exportation of opium and other drugs in warehouse, soft opium was allowed to be separated from hard opium and repacked in warehouses

for exportation, the hard opium to be withdrawn for consumption. (Treasury Order, T. D. 6572 and 6753.)

No allowances to be made in determining the weight of crude opium for refuse matter to be ascertained and separated by boiling the opium. (Treasury Order, T. D. 7648.)

Crude opium containing less than 9 per cent of morphia not to be released upon payment of a fine equal to the duty under a law forbidding its importation. Exportation the only remedy. (Treasury Order, T. D. 7694.)

Moist opium gum containing from 5.72 per cent to 6.38 per cent of morphia, according to the method of analysis, held to be crude opium containing less than 9 per cent of morphia and not entitled to entry for consumption in the United States. (Treasury Order, T. D. 8098.)

The use of stamps upon imported opium discontinued because furnishing opportunity to smugglers and others to defraud the revenue. (Treasury Order, T. D. 9263.)

Opium ashes found to contain 6.02 per cent of morphia held to be dutiable under the act of 1883 as a preparation of opium and not as crude opium. (Treasury Order, T. D. 9413.)

Squibbs' methods of analysis approved for determining the percentage of morphia in crude opium. (Treasury Order, T. D. 9754.)

Powdered opium.—Subjected to a carefully regulated artificial heat which evaporated the moisture without destroying the alkaloid in the opium, then grinding it to powder, sifting it, and adding sufficient morphia to bring it up to the standard of the United States Pharmacopœia. There was no specific provision prior to the act of 1909. In litigation under the act of 1897 such opium was held to have been advanced from the condition of crude or unmanufactured opium and dutiable under paragraph 20 as a drug advanced in value or condition by refining and grinding. (Merck *v.* U. S., 151 Fed., 14 (T. D. 27768), reversing 143 Fed., 694 (T. D. 27024); U. S. *v.* McKesson, 172 Fed., 168 (T. D. 29860).)

Muriate or hydrochlorate of cocaine.—There was considerable litigation upon the dutiable classification of this merchandise. In G. A. 886 (T. D. 11973) and G. A. 1563 (T. D. 13058) the Board of General Appraisers held the provision under paragraph 74, act of 1890, for medicinal preparations in which alcohol was used to be more specific than the provision in paragraph 76 for alkaloids and chemical compounds and salts. This classification was overruled by the Circuit Court of Appeals for the Fourth Circuit in United States *v.* Battle (50 Fed., 402 (T. D. 13730), 54 Fed., 141). Upon a new record (T. D. 14362) the board adhered to its former decision and was again reversed, this time by the Circuit Court for the Southern District of New York. (In re Merck, 66 Fed., 714 (T. D. 14979).)

The question also arose in the eighth circuit. The circuit court of appeals in in re Mallinckrodt Chemical Works, 66 Fed., 746 (T. D. 15114) held the provision for alkaloids and chemical salts in paragraph 76, act of 1890, was more specific than the provision for medicinal preparations in paragraph 74. Another case was thereupon prosecuted in the second circuit. The circuit court in Lehn and Fink *v.* United States, 66 Fed., 748 (T. D. 15639) held paragraph 76 to be the correct classification, but the circuit court of appeals certified the question to the Supreme Court, which in a case reported as Fink *v.*

United States, 170 U. S., 584, held the provision for medicinal preparations more specific than the provision for chemical compounds and salts.

This decision was applied by the board to compounds of cocaine (G. A. 4211; T. D. 19629), and to muriate of cocaine, thus reaffirming its original decision in G. A. 886 (T. D. 11973) supra, and its reasoning in G. A. 2640 (T. D. 15114).

Liquor opii sed held to be dutiable as a liquid preparation of opium under paragraph 47, act of 1890. (G. A. 881 (T. D. 11968).)

Crude cocaine, an alkaloid derived from the leaves of the coca plant, in the extraction and purification whereof alcohol is used, held dutiable as a chemical compound under the act of 1890 and not as a medicinal preparation in which alcohol is used. Occasional use upon the surface of the skin for surgical and dental purposes, was declared not to constitute it a medicinal preparation. (Hirzel *v.* U. S., 58 Fed., 772, affirming 53 Fed., 1006 and G. A. 1531 (T. D. 12980); followed in G. A. 2405 (T. D. 14647).)

Cocaine phenate held dutiable under the act of 1890 as a chemical compound or salt and not as a medicinal preparation. (G. A. 2624 (T. D. 15071).)

Aqueous extract of opium held to be smoking opium, the importation of which is prohibited. (Dept. Order, T. D. 34598.)

Opium dried, and sliced, and dried, sliced and crushed, held dutiable under the act of 1897 as a drug (gum) advanced in value or condition and not as opium crude or unmanufactured. (G. A. 7001 (T. D. 30487).) Overruled by next case.

Opium in bricks, cakes, or lumps held not to be dried but dutiable under the act of 1897 as crude or unmanufactured and not adulterated, containing 9 per cent or over of morphia. (Merck *v.* U. S., 5 Ct. Cust. Appls., 347 (T. D. 34549), reversing G. A. 7501 (T. D. 33788).)

Codein hydrochlorate, codein sulphate in powder, codein pure crystals, and codein pure precipitate, produced from morphine, held to be dutiable as alkaloids of opium and not "salts of opium," which term was interpreted to mean such salts as are produced by the chemical action of an acid radical on organic bases rather than component parts of opium. (Merck *v.* U. S., 6 Ct. Cust. Appls., 41 (T. D. 35315), affirming G. A. 7517 (T. D. 33998).)

Opium containing more than 15 per cent of moisture was held dutiable under the act of 1897, at $1.50 per pound; containing 15 per cent or less, at $2 per pound. (Dept. Order, T. D. 31388, but see Merck *v.* U. S., 5 Ct. Cust. Appls., 347, above.)

Smoking opium seized for violation of the act of February 9, 1909 (amended, supra), may be summarily forfeited and destroyed by collectors of customs without judicial proceedings. (Dept. Order, T. D. 33069, following the opinion of the Attorney General, 29 Opin. Atty. Gen., 603.)

The act of February 9, 1909 (amended, supra), prohibiting the importation of opium for other than medicinal purposes did not repeal that portion of the act of October 1, 1890 (26 Stat. 620, 621), which related to the manufacture or preparation in the United States of opium for smoking. Neither said act of 1909 nor any other act abrogated or dispensed with the necessity of observing the requirements of section 37 of said act of 1890 as to notices, inventories, bonds, books, returns, etc. (29 Opin. Atty. Gen., 108.)

The act of February 9, 1909 (amended, supra), prohibited the importation of opium into the United States except for medicinal purposes under regulations, and provided that if any person should knowingly import or bring into the United States any opium contrary to law, or should receive, conceal, buy, sell, or in any manner facilitate the transportation and concealment or sale of such opium or derivative thereof after importation should be guilty of an offense; *held*, that the offense described was committed whenever smoking opium was fraudulently and knowingly brought by the offender within the territorial limits of the United States, the offense being complete, though the opium may not have been landed from the ship or carried across the customs line. The steward of a vessel bound for Philadelphia found to have smoking opium in his possession as the vessel was proceeding up Delaware Bay violated the act. (U. S. *v.* Caminata, 194 Fed., 903 (T. D. 32736).)

The offense was committed when smoking opium was fraudulently and knowingly brought within the territorial limits of the United States, although the opium may not have been landed from the ship, possession within the territory of the United States being sufficient evidence of guilt to justify conviction. (U. S. *v.* Caminata, T. D. 32397.)

A Chinese claiming to be a British subject can not lawfully import opium into the United States under Article II, treaty with China, proclaimed on October 5, 1881, unless positive proof is presented that he is such a subject. (Dept. Order, T. D. 18779.)

An indictment for smuggling "smoking opium" and "prepared opium" was held to sufficiently describe dutiable merchandise under schedule A, act of 1890 (or 1883), imposing a duty on "opium prepared for smoking and all other preparations of opium not specially enumerated or provided for in this act." (U. S. *v.* Gardner, 42 Fed., 832.)

Opium shipped on board a vessel at Honolulu for Panama, intended for transshipment at San Francisco and entered on the manifest and bills of lading and reported to the collector as being in transit for Panama, the owner having applied to the collector for a permit to make the transshipment and offered to give the security prescribed by the statute without obtaining a permit, was held not to be dutiable and illegally seized for nonpayment of duties. (McLean *v.* Hager, 31 Fed., 602.)

Opium could not, under the laws existing at the time of the passage of the act of February 9, 1909 (amended, supra), be brought into a port of the United States from a foreign country and exported from the same port on another vessel without being subject to duty. After said act of 1909, prohibiting absolutely the importation of opium in any form, smoking opium was not subject to duty and could not under any circumstances be entered and bonded for warehousing; and the law which made the bringing of opium into a port an importation for such purposes was, as to smoking opium, repealed. (27 Opin. Atty. Gen., 440.)

Smoking opium seized under the act of 1914 (supra) as a preparation or derivative of opium, directed to be sent to the Public Health Service and not destroyed pending the result of investigation. (Dept. Order, T. D. 37094.)

OPIUM DERIVATIVES.

(Par. 47, Act of 1913.)

SUMMARY.

DESCRIPTION.

Derivatives and preparations of opium may be considered in two categories:

(1) Opium alkaloids and their derivatives. Morphine, codeine, and heroin or diacetylmorphine are of chief importance.

(2) Medicinal preparations of opium. These are of importance in domestic pharmaceutical manufacture; the high ad valorem rate imposed by recent tariffs has virtually eliminated them from import.

Opium derivatives are used legitimately in medicine to relieve pain and induce sleep. Their continued use induces a habituation which produces moral and physical degeneration, and is considered virtually incurable by medical authorities. An ounce of morphine contains about 3,500 medicinal doses; an ounce of heroin, about 8,800.

DOMESTIC PRODUCTION.

Morphine is extensively manufactured in America from imported opium. The average annual opium import (prewar, about 480,000 pounds) is equivalent to about 690,000 ounces, or 2,500,000,000 medicinal doses of morphine. Considerable amounts of opium, however, are used for other purposes, and statistics of morphine manufacture have not been obtainable.

Heroin, formerly a German product, is now manufactured in this country. It was introduced as a "nonhabit-forming" substitute for morphine, but is even more dangerous in this connection than morphine, and its use is coming into disfavor in the medical profession.

American codeine manufacture is largely an outgrowth of war conditions. Persian opium, which is now chiefly imported, contains a much larger proportion of codeine than the Turkish article, which formerly almost monopolized the American market. Codeine is produced as a by-product of morphine manufacture.

The levy of $3 per pound on 9 per cent opium is equivalent to a tax of $2.07 per ounce on the contained alkaloid, leaving a margin in favor of the American manufacturer of 93 cents per ounce. This, the profit gained from codeine and other by-products, together with import restrictions beyond the purview of the tariff, has resulted in a virtual monopoly of the American morphine market for the American manufacturer. The manufacture of opium alkaloids requires considerable amounts of alcohol; other chemicals used vary with the process; alcohol and labor are probably the chief costs.

FOREIGN PRODUCTION.

Opium alkaloids are extensively manufactured in England and Germany. These countries, prior to the war, led in the manufacture

of opium alkaloids other than morphine, Germany in particular producing a large variety of the rarer alkaloids and salts. During the war considerable amounts of Indian opium, barred from the United States on account of low morphine content, is said to have been used by British manufacturers. In British India, also, morphine is now being manufactured.

IMPORTS.

Imports under recent high tariffs have been small as compared to American manufacture, and have consisted mainly of the rarer alkaloids and salts. War conditions have rendered the demand for opium products virtually independent of price, and considerable increases of import took place in 1917 and 1918. That increases were not larger is doubtless due to universal scarcity and export restrictions of other nations rather than to high prices or the present tariff rates.

Imports of morphine fell off under the present tariff rates from an annual average (1910–1913) amount of 18,004 ounces and value of $93,812 to (1914–1917) 2,805 ounces and $9,820. In 1918 they rose to 25,215 ounces, valued at $202,263. Other alkaloids have in recent years pursued a much more irregular course, ranging (1909–1916) from 480 ounces, valued at $2,545 (1911) to 21,870 ounces, worth $64,306 (1910). For 1917 and 1918, 34,179 ounces and 20,479 ounces, valued at $165,028 and $126,882, are reported.

Imports of laudanum and similar preparations have, in recent years, passed $5,000 in value only in 1915. They are quite insignificant as compared with domestic manufacture.

Conditions of import and sale of opium products are strictly regulated by legislation other than tariff acts. (See catalogue on opium.)

REVENUES.

Under the tariff of 1909 opium alkaloids yielded an average annual[1] revenue of $34,838. The tariff of 1913 has yielded annually (1914–1918) $63,943.

PRICES.

Declared import values of morphine have fluctuated from $2.06 per ounce in 1910 to $8.02 in 1918. Other alkaloids have varied in the same period from $2.33 to $6.19.

Morphine sulphate, the principal salt, has varied on the New York drug market (1912–1918) from $4.20 (1913) to $12.80 (1917), closing (1918) at $11.80. The alkaloid has ranged from $1.50 to $4 higher. Heroin (1917) reached $17.65. Codeine ranged from $5.25 (1913) to $11.30 (1918).

TARIFF HISTORY.

Morphine is first mentioned in the act of April, 1861, dutiable at $1 per ounce. In subsequent acts it has continued to bear a high specific rate, from 50 cents (1894) to $3 (1913). Laudanum and opium extracts and preparations have been assessed 40 per cent ad valorem by all acts since 1883 save 1894 (20 per cent) and 1913 (60 per cent).

[1] Fractional parts of years considered as whole years.

TARIFF QUESTIONS INVOLVED.

These are in the main identical with those discussed under opium. It appears to have been the intent of Congress to restrict the consumption of opium products to those of American manufacture, but the motive involved has been regulatory rather than protective. The rates imposed have presumably been designed to discourage importation without inciting a smuggling trade in these easily concealed products.

GENERAL INFORMATION.

The derivatives and preparations of opium recognized by the tariff act of 1913 are:

Morphia or morphine, sulphate of, and all alkaloids of opium, and salts and esters thereof, dutiable at $3 per ounce. Aqueous extract of opium for medicinal uses, and tincture of, as laudanum, and other liquid preparations of opium not specially provided for in this section, 60 per cent ad valorem.

THE OPIUM ALKALOIDS AND THEIR DERIVATIVES.

The opium alkaloids number about 25. Of these the chief in importance are morphine, codeine, narcotine, thebaine, narceine, papaverine; the others are present only in minute proportions and will not be considered here. Apomorphine, apocodeine, dionine, peronine, and heroin are artificial derivatives. All opium alkaloids and their derivatives come within the scope of the Harrison narcotic law.

The alkaloids of opium may be divided chemically into two distinct groups: (1) The morphine group, consisting of morphine, codeine, pseudomorphine, hydroxycodeine, and thebaine, strong bases, very poisonous, complex derivatives of phenanthrene; and (2) the narcotine-papaverine group, which possess little physiological action and, so far as their constitution is known, are derivatives of isoquinoline. The names of the alkaloids, as used in common speech, include the salts as well.

MORPHINE GROUP.

Morphine is the principal alkaloid of opium. Its amount varies widely in different opiums from less than 1 per cent to nearly 25 per cent, being in ordinary medicinal opium from 9 per cent to 11 per cent. Its formula is usually written $C_{17}H_{19}O_3N + H_2O$.

History of morphine.—Morphine was the first alkaloid to be obtained from the plant kingdom, being first isolated from opium in 1806. It has also been found in some other plants, as *Argemone mexicana* L. (Papaverceæ) and in wild American hops, *Humulus lupulus* L. (Urticacæ), but these sources are of only academic importance

Morphine was for a long time chiefly manufactured in England, but for the last two decades or more practically all morphine used in America has been of domestic manufacture. Importations of the rarer alkaloids or derivatives exceed those of morphine. While no statistics of domestic manufacture have been compiled, it was estimated by Dr. Koch, the vice president of the State Pharmaceutical Examining Board of Pennsylvania, and chairman of the legislative committee of the Philadelphia Association of Retail Druggists, that

80 per cent of imported opium was used for the extraction of morphine. Taking the normal import of opium as 400,000 pounds, and its morphine content at 9 per cent, the annual morphine manufacture of the United States would amount to about 30,000 pounds, or 500,000 ounces, annually. Besides England, morphine is also manufactured in Germany, France, and Japan.

Preparation of morphine.—Morphine occurs in opium as the meconate and sulphate.

It may be commercially prepared in several ways, and different manufacturers follow special procedures. One of the simplest methods is that of Staples, in which the opium is exhausted by repeated maceration with cold water; the infusions are concentrated and filtered, after which alcohol and ammonia water are added, whereupon crude morphine crystallizes out on standing, and is purified by dissolving in hot alcohol, treatment with animal charcoal, and recrystallization.

By the Gregory-Anderson method opium is exhausted in cold water, the liquid is concentrated, strained, and mixed with calcium chloride; the hydrochlorides of the alkaloids remain in solution, while most of the other constituents are precipitated as calcium compounds. After filtration, morphine and codeine salts crystallize out, while narcotine and other alkaloids remain in solution. The crystals are dissolved in water, boiled with animal charcoal to remove impurities, recrystallized, and redissolved in water. Upon the addition of ammonia water morphine is precipitated and codeine remains in solution.

In Merck's process a concentrated opium infusion is precipitated by means of sodium carbonate. The precipitate is washed with water and alcohol, whereupon the minor alkaloids and certain other impurities are removed. The crude morphine is dissolved in dilute acetic acid, while narcotine remains undissolved. After filtration through animal charcoal the morphine is precipitated with ammonia water, washed, and dried.

Salts of morphine.—Morphine is relatively insoluble and is rarely used as the alkaloid, but when combined with acids it forms soluble salts which are much employed. The official salts are the hydrochloride or chlorhydrate, and the sulphate; the sulphate is most common and is usually meant when "morphine" is referred to in common parlance. The acetate and tartrate are frequently used; the therapeutic value of the pure salts is practically identical; they differ mainly in stability and solubility. Other salts have been employed but are of minor importance.

Action and uses.—Morphine has three principal actions—a specific central analgesic or pain-relieving action; a depressant action on the entire central nervous system, resulting in sleep; and a constipating effect. Small doses relieve pain, and larger doses produce sleep. The action is, in its essentials, that of opium, but in the latter it may be complicated by the action of codeine and narcotine.

Morphine is administered orally or hypodermically and is used chiefly as an analgesic in cases of severe or incurable pain. In chronic conditions the continued use of morphine is almost sure to result in addiction to the drug, and the best clinicians of to-day tend more and more to use it rarely and as a last resort, for the morphine habit is one of the most easily established, most disastrous, and most difficult to cure of all drug addictions; it is also doubtless the most common.

It has been estimated, judging from the proportionate amounts of morphine and opium used in the United States, and in European countries where morphinism is practically unknown, that 75 per cent of the morphine used in this country is used by drug addicts. This state of affairs was brought about by the too-frequent prescription of morphine by physicians, its frequent unannounced presence in secret remedies, and the ease with which, until very recent years, it could be obtained. These conditions, as regards secret remedies and free sale of morphine, have been largely improved by the enforcement of the food and drugs act, the Harrison narcotic law, and the legislation of the various States, which have been referred to more in detail under "Opium."

Morphine is probably the most common habit-forming drug used in proprietary medicines, being an especially common ingredient of so-called "soothing sirups," "anodynes," cough and cold remedies, and drug-addiction treatments. The existence of morphine and its derivatives, formerly expressly denied on the labels of many such "remedies" before the enactment of the food and drugs act, is required by that act to be specifically declared, with a statement of the amount present. Preparations containing over one-fourth of 1 per cent of morphine come within the restrictions of the Harrison narcotic laws.[1]

The morphine habit has been induced also by the smoking of opium. This has occurred more frequently in the Orient than in America; the antiopium movement in China was accompanied by a flood of "antiopium" remedies whose active ingredient was morphine, and also by the wholesale smuggling of morphine across the Chinese border. The situation was rendered worse by the cheapness of morphine per dose as compared with opium—$1 worth going as far, as regards effect, as $3 worth of opium—and the comparative ease with which such a concentrated article can be secretly transported. The morphine situation in China is set forth at length in the "Memorandum on Opium" presented to the International Opium Commission in Shanghai in 1909, and morphine and instruments for its injection form the subject of portions of the restrictive international agreement known as the international opium convention, signed at The Hague in 1912. (See article on opium.)

The symptoms and effects of morphine, or addiction to any of its analogues, are described under "Opiumism" in the article on opium.

DERIVATIVES OF MORPHINE.

Aside from the salts already mentioned, the principal derivatives of morphine are diacetyl morphine or heroin, and its hydrochlorid, ethyl-morphine and its hydrochloride-dionin and apomorphine.

Diacetyl morphine, or heroin.—Heroin is the proprietary name for this substance as manufactured by Farbenfabriken, vom. Friedr. Bayer & Co., Leverkusen, Germany (The Bayer Co. (Inc.), New York).

Diacetylmorphine may be obtained by heating pure morphine with acetyl chloride, washing the product with dilute sodium car-

[1] Harrison narcotic laws, Dec. 17, 1914, and Feb. 24, 1919.

bonate solution, and crystallizing from hot alcohol. Its principal compound, the hydrochloride, is formed by dissolving diacetylmorphine in diluted hydrochloric acid, concentrating, and crystalizing. It also is manufactured by Farbenfabriken.

Uses.—Both diacetylmorphine and its hydrochlorid are official. Both are commonly referred to as "heroin." In action heroin approaches morphine very closely. It formerly gained considerable popularity as a "nonhabit-forming" drug, but experience has shown that it is even more liable than morphine to produce habit and toxic effects, and that it is in no way superior to it. Heroin is a common ingredient of cough mixtures, especially of the proprietary type. The Harrison narcotic law restricts the sale of preparations containing over one-eighth of a grain of heroin per fluid ounce.

Heroin has been dropped from the most recent edition of "Useful Drugs," the handbook of the American Medical Association; the compilers state that "on the whole, its introduction has been harmful, in that it furnished a specious means * * * for avoiding the well-founded popular fears of morphine by substituting another habit-forming drug."

Ethylmorphine.—This is employed in the form of its hydrochloride, which is official. Ethylmorphine is obtained by the action of ethyl iodide on morphine in the presence of an alkali. It is purified by crystallization from hot alcohol, dissolved in hot water neutralized by hydrochloric acid, whereupon the hydrochloride is obtained by crystallization. It is usually known as "dionin," under which name it is manufactured by E. Merck, Darmstadt, Germany. (Merck & Co., New York.)

Uses.—Dionin is used internally as a substitute for morphine to relieve pain or cough. Its action is intermediate between morphine and codeine, and for internal use it is now considered to possess no advantage over codeine. Its principal present-day use is in certain diseases of the eye. It is slightly less habit-forming than morphine.

Apomorphine.—This artificial alkaloid is also employed as the hydrochlorid, which is official.

Apomorphine is prepared from morphine by the abstraction of 1 molecule of water. Morphine is heated in a closed tube with hydrochloric acid, after which the contents of the tube are diluted with air-free distilled water, supersaturated with sodium bicarbonate, filtered, and the apomorphine extracted with chloroform or ether. The hydrochlorid is obtained by treatment with hydrochloric acid. Apomorphine may also be prepared from morphine hydrochloride by heating with zinc chloride, or by heating codeine with hydrochloric acid.

Apomorphine hydrochlorid differs markedly in physiological action from morphine. Small doses are hypnotic, but its chief use is as an emetic, for which purpose it is one of the most frequently used drugs. Its main advantage over ipecac, tartar emetic, and other drugs of this class lies in that it acts on the "vomiting center" of the medulla oblongata independently of a local action on the stomach. It is frequently used in cases of poisoning. Apomorphine hydrochloride may be given orally or hypodermically. It is commonly used as a nauseant in institutions for the cure of the liquor habit.

CODEINE.

Codeine occurs in Turkish opium to the amount of 0.3 to 0.4 per cent, and sometimes reaches 3 per cent in Persian opium. It is manufactured to a considerable extent in Germany. Chemically it is methyl ether of morphine.

Codeine may be prepared from opium as a by-product of the Gregory-Anderson method. The ammoniacal filtrate remaining after the removal of morphine is concentrated; the codeine hydrochlorid is dissolved in hot water, and potassium hydroxid is added, whereupon a portion of the codeine crystallizes on cooling, and more is obtained as an oily liquor which slowly solidifies. The alkaloid is further purified by washing in water, decolorizing, and crystallizing from water.

Codeine may also be derived from morphine by treatment of the latter with potassium hydroxid, methyl alcohol, and nitroso-methyl-urethane; by action of methyl iodide or methyl chloride or of sodium methylsulphate upon an alkaline solution of morphine.

Uses.—Codeine and its phosphate and sulphate are official. The salts are more soluble than the alkaloid, and their therapeutic uses are the same. In its physiological action codeine resembles morphine, but is less constipating and possesses less narcotizing power. It is used widely in place of morphine as a sedative; it is considered slightly less habit-forming, and therefore better suited to repeated administration.

It is largely used in cough mixtures and is a common ingredient of proprietaries. It is a frequent but uncertain agent in diabetes. The Harrison narcotic law restricts the sale of preparations of codeine containing over 1 grain of codeine per ounce.

Eucodin, methyl-codeine bromide, is a German preparation which has recently attracted some attention as a substitute for codeine; it is claimed to be much less toxic.

Apocodeine and its hydrochloride possess properties similar to apomorphine.

THEBAINE.

Thebaine occurs in opium to the amount of 0.4 per cent. It is a marked convulsive poison, responsible for some of the disadvantages of the crude drug and is not used therapeutically.

THE NARCOTINE—PAPAVERINE GROUP.

Narcotine is, as regards amount, the second alkaloid of opium, being normally present to about 5 per cent. It resembles codeine somewhat, but is weaker. The name is a misnomer; it has little or no narcotic power. The hydrochloride is used as an antiperiodic, but is of little importance. Cotarnine and stypticin are derivatives used as hæmostatics.

Papaverine ranks third as regards amount, reaching 0.8 per cent in average opium. It has not been widely used in medicine, but has recently attracted some attention in hypertonic conditions. It relaxes smooth muscle in general, although different organs are affected in differing degree. The alkaloid, hydrochloride, and sul-

phate are listed in New and Non-Official Remedies, 1917. They are manufactured by E. Merck, Darmstadt, Germany (Merck & Co., New York), and F. Hoffman-La Roche Co., Basel, Switzerland (Hoffman-La Roche Chemical Works, New York).

LIQUID PREPARATIONS OF OPIUM.

Aqueous extract of opium.—The United States Pharmacopœia recognizes no aqueous extract of opium. The British Pharmacopœia recognizes no aqueous extract of opium. The British Pharmacopœia recognizes a "liquid extract of opium," which is an extract of opium which contains 18 per cent alcohol and 0.75 per cent morphine. The alcohol is added chiefly as a preservative. While the active principles of opium may be extracted by water, either desiccation, as in case of the official extract of opium, or the addition of a certain proportion of alcohol is essential to preservation. A strictly "aqueous" extract, therefore, would hardly enter commerce. By T. D. 34598, "aqueous extract of opium" was held to be smoking opium, the importation of which is forbidden by act of Congress.

Tinctures of opium.—The tincture of opium of the United States Pharmacopœia, commonly known as laudanum, is an alcoholic solution containing 1 per cent of morphine. The deodorized tincture of opium, U. S. P., is a similar preparation from which, in the process of making, the odorous and nauseant principles have been removed. Tinctures of opium of 1 per cent morphine strength are official in most pharmacopœias. They are used as additions to anodyne liniments, poultices, etc., and also for internal administration.

Camphorated tincture of opium, U. S. P., commonly known as paregoric, contains 0.05 per cent of morphine, as well as benzoic acid, camphor, oil of anise, and glycerin. Similar preparations are common to other pharmacopœias. They possess anodyne and carminative properties and are largely employed to relieve abdominal pain, to allay cough, and as a sedative for infants.

Under "liquid preparations of opium not specially provided for" would presumably be included proprietary medicines containing opium and its derivatives.

WAR DISTURBANCES.

The derivatives of opium, especially morphine, have followed the sensational course of opium. Several manufacturers were forced to abandon production on account of the opium shortage. Army and export demands were heavy; Russia and Japan were two of the largest consumers of export material, and heavy exports to England, France, and Italy have also been noted. The elimination of the large prewar German supply also had its effect, especially as regarded some of the rarer derivatives. Morphine, at $4.70 per ounce when the war opened, rose to $12.80 in 1917. Codeine was less affected by war conditions, and during 1917 large shipments were received from England.

Derivatives of opium imported contrary to law and seized by customs officials were sequestered for the use of the Government.

Opium and manufactures of, aqueous, extracts of, for medicinal uses, and tincture of, as laudanum and other liquid preparations of, n. s. p. f.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:						*Per cent.*
1908	40 per cent		$600	$240		40
1909	do		407	162		40
1910	do		342	136		40
1911	do		3,693	1,477		40
1913	do		671	268		40
1914 [1]	do		1,168	467		40
1914 [2]	60 per cent		4,111	2,466		60
1915	do		5,565	3,339		60
1916	do		6	3		60
1917	do		222	133		60
1919	do		70	42		60
Calendar years:						
1919			10	70	$42	60
1920 [3]			46	28	15	60

[1] Act of 1909, July 1 to Oct. 3, 1913. [2] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[3] Six months ending June 30, 1920.

Opium and manufactures of, morphia, or morphine, sulphate of—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Ounces.*				*Per cent.*
1908	$1 per ounce	753	$2,713	$753	$3.60	27.75
1909	do	152	392	152	2.57	38.88
1910 [1]	do	32	66	32	2.06	48.48
1910 [2]	$1.50 per ounce	13,050	60,071	19,575	4.60	32.59
1911	do	20,345	95,067	30,517	4.67	32.10
1912	do	13,825	78,891	20,737	5.71	26.29
1913	do	24,797	141,221	37,195	5.70	26.34
1914 [3]	do	4,235	9,822	6,352	2.32	64.68
1914 [4]	$3 per ounce	1,570	4,398	4,710	2.80	107.10
1915	do	1,383	3,300	4,149	2.38	125.73
1916	do	2,685	8,906	8,055	3.31	90.44
1917	do	5,584	22,675	16,752	4.06	73.88
1918	do	25,215	202,263	75,645	8.02	37.40
1919	do	25,370	158,307	76,110	6.24	48.08
Calendar years:						
1918	do	30,385	226,349	91,155	7.44	40.27
1919	do	15,760	86,451	47,280	5.47	54.69
1920 [5]	do	3,250	9,458	9,750	2.91	103.08

[1] Act of 1897, July 1 to Aug. 5, 1909. [2] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909, July 1 to Oct. 3, 1913. [4] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[5] Six months.

Opium and manufactures of, all other alkaloids of opium, and salts and esters thereof—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Ounces.*				*Per cent.*
1908	$1 per ounce	2,050	$6,623	$2,050	$3.23	30.95
1909	do	3,779	10,106	3,779	2.67	37.39
1909 [1]	$1 per ounce less 20 per cent	3	7	2	2.33	34.29
1910 [2]	$1 per ounce	1,100	2,558	1,100	2.33	43.00
1910 [3]	$1.50 per ounce	21,870	63,406	32,805	2.90	51.76
1911	do	480	2,545	720	5.30	28.31
1912	do	634	1,742	951	2.75	54.60
1913	do	9,672	28,587	14,508	2.96	50.75
1914 [4]	do	7,086	39,371	10,629	5.56	27.00
1914 [5]	$3 per ounce	4,507	25,157	13,521	5.58	53.75
1915	do	8,626	49,584	25,878	5.74	52.19
1916	do	2,360	9,981	7,080	4.22	70.93
1917	do	34,179	165,028	102,537	4.82	62.13
1918	do	20,479	126,882	61,437	6.19	48.42
1919	do	56,895	318,361	170,685	5.60	53.61
Calendar year—						
1918	do	59,270	341,771	177,810	5.76	52.03
1919 [5]	do	31,909	189,176	95,727	6.25	50.52
1920 [6]	do	6,184	28,139	18,552	4.55	65.92

[1] From Cuba (reciprocity treaty, Dec. 27, 1903).
[2] Act of 1897, July 1 to Aug. 5, 1909.
[3] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[4] Act of 1909, July 1 to Oct. 3, 1913.
[5] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[6] Six months.

Codeine, phosphate—Prices per ounce, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Jan. 3, 1916 [1]	$6.35–$6.55	July 1, 1918	$6.80–$6.90
Apr. 3, 1916	6.35	Oct. 7, 1918	7.60– 7.75
July, 1916	6.35	Jan. 6, 1919	8.35– 8.50
October, 1916	6.35	Apr. 7, 1919	8.35– 8.50
January, 1917	7.40– 7.60	July 7, 1919	8.35– 8.50
April, 1917	10.30	Oct. 6, 1919	7.90– 7.95
July, 1917	10.30	January, 1920	8.45– 8.55
October, 1917	9.40	April, 1920	8.45– 8.55
Dec. 31, 1917	8.30– 8.50	July, 1920	8.45– 8.55
Jan. 5, 1918	8.30– 8.50	October, 1920	8.45– 8.55
Apr. 1, 1918	7.50– 7.60		

[1] Not quoted prior to 1916.

Codeine, sulphate—Prices per ounce, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

January, 1917 [1]	$7.90–$8.10	Jan. 6, 1919	$8.90–$9.95
April, 1917	11.00	Apr. 7, 1919	8.90– 9.95
July, 1917	11.00	July 7, 1919	8.90– 9.95
October, 1917	10.00	Oct. 6, 1919	8.40– 8.45
Dec. 31, 1917	8.85– 9.05	January, 1920	9.00– 9.10
Jan. 5, 1918	8.85– 9.05	April, 1920	9.00– 9.10
Apr. 1, 1918	8.00– 8.10	July, 1920	9.00– 9.10
July 1, 1918	7.30– 7.40	October, 1920	9.00– 9.10
Oct. 7, 1918	8.10– 8.25		

[1] Not quoted prior to 1917.

Codeine, alkaloid—Prices per ounce, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$6.25–$6.40	July, 1916	$8.50
Apr. 1, 1912	5.95– 6.10	October, 1916	8.50
July 1, 1912	5.65– 5.80	January, 1917	$9.85–10.05
Sept. 30, 1912	5.35– 5.50	April, 1917	14.75
Dec. 30, 1912	5.65– 5.80	July, 1917	14.75
Mar. 29, 1913	5.25– 5.40	October, 1917	12.50
June 30, 1913	5.25– 5.40	Dec. 31, 1917	11.05–11.25
Sept. 29, 1913	5.25– 5.40	Jan. 5, 1918	11.05–11.25
Dec. 29, 1913	5.75– 5.90	Apr. 1, 1918	10.00–10.10
Mar. 30, 1914	5.75– 5.90	July 1, 1918	9.15– 9.25
June 29, 1914	5.75– 5.90	Oct. 7, 1918	10.15–10.30
August, 1914	5.75– 5.90	Jan. 6, 1919	11.15–11.30
Oct. 1, 1914	7.00– 7.15	Apr. 7, 1919	11.15–11.30
Jan. 1, 1915	6.45– 6.50	July 7, 1919	11.15–11.30
Apr. 1, 1915	6.45– 6.50	Oct. 6, 1919	10.55–10.60
July 1, 1915	6.45– 6.50	January, 1920	11.30–11.40
Oct. 1, 1915	6.45– 6.50	April 1920	11.30–11.40
January, 1916	6.55– 8.60	July, 1920	11.30–11.40
April, 1916	6.55	October, 1920	11.30–11.40

Codeine, acetate—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

October, 1917[1]	$11.30	Apr. 7, 1919	$10.00–$10.15
Dec. 31, 1917	$9.25– 10.15	July 7, 1919	10.00– 10.15
Jan. 5, 1918	9.25– 10.15	Oct. 6, 1919	9.45– 9.50
Apr. 1, 1918	9.00– 9.10	January, 1920	10.15– 10.25
July 1, 1918	8.20– 8.30	April, 1920	10.15– 10.25
Oct. 7, 1918	8.65– 8.75	July, 1920	10.15– 10.25
Jan. 6, 1919	10.00– 10.15	October, 1920	10.15– 10.25

[1] Not quoted prior to October, 1917.

Codeine, muriate—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

July, 1916[1]	$7.50	Oct. 7, 1918	$9.10– $9.25
October, 1916	7.50	Jan. 6, 1919	10.00– 10.15
January, 1917	$8.85– 9.05	Apr. 7, 1919	10.00– 10.15
April, 1917	12.40	July 7, 1919	10.00– 10.15
July, 1917	12.40	Oct. 6, 1919	9.45– 9.50
Dec. 31, 1917	9.95	January, 1920	10.15– 10.25
Jan. 5, 1918	9.95	April, 1920	10.15– 10.25
Apr. 1, 1918	9.00– 9.10	July, 1920	10.15– 10.25
July 1, 1918	8.20– 8.30	October, 1920	10.15– 10.25

[1] Not quoted prior to 1916.

Codeine, nitrate—Prices per ounce, wholesale, New York, spot

[From Oil, Paint, and Drug Reporter.]

Dec. 31, 1917[1]	$9.95–$10.15	July 7, 1919	$10.00–$10.15
Jan. 5, 1918	9.95– 10.15	Oct. 7, 1919	9.45– 9.50
Apr. 5, 1918	9.00– 9.10	January, 1920	10.15– 10.25
July 1, 1918	8.20– 8.30	April, 1920	10.15– 10.25
Oct. 6, 1918	9.10– 9.25	July, 1920	10.15– 10.25
Jan. 6, 1919	10.00– 10.15	October, 1920	10.15– 10.25
Apr. 7, 1919	10.00– 10.15		

[1] Not quoted prior to December, 1917.

Morphine, ethyl hydrochloride—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1915[1]	$7.15–$7.35	Jan. 5, 1918	$18.05
Apr. 1, 1915	7.15– 7.35	Apr. 1, 1918	18.05
July 1, 1915	7.15– 6.35	July 1, 1918	18.05
Oct. 1, 1915	7.15– 7.35	Oct. 7, 1918	18.00
January, 1916	7.15– 7.35	Jan. 6, 1919	18.00
April, 1916	7.15– 7.35	Apr. 7, 1919	$16.05–16.25
July, 1916	7.65– 7.75	July 7, 1919	16.05–16.25
October, 1916	7.65– 7.75	Oct. 6, 1919	13.45–13.60
January, 1917	8.85– 9.10	January, 1920	13.45–13.60
April, 1917	15.00	April, 1920	13.45–13.60
July, 1917	15.00	July, 1920	12.45–12.60
October, 1917	17.10	October, 1920	12.45–12.60
Dec. 31, 1917	18.05		

[1] Not quoted prior to 1915.

Morphine, diacetyl alkaloid (heroin)—Prices per ounce wholesale, New York, spot, 5-ounce cans.

[From Oil, Paint, and Drug Reporter.]

April, 1917 [1]	$14.00	Jan. 6, 1919	$17.45
July, 1917	14.00	Apr. 7, 1919	$15.50–15.75
October, 1917	16.35	July 7, 1919	15.50–15.75
Dec. 31, 1917	17.65	Oct. 6, 1919	13.05–13.10
Jan. 5, 1918	17.65	January, 1920	13.05–13.10
Apr. 1, 1918	17.65	April, 1920	13.05–13.10
July 1, 1918	17.65	July, 1920	11.85–11.95
Oct. 7, 1918	17.45	October, 1920	11.85–11.95

[1] Not quoted prior to April, 1917.

Morphine, diacetyl hydrochloride (heroin hydrochloride)—Prices, per, ounce wholesale, New York (5-ounce cans).

[From Oil, Paint, and Drug Reporter.]

Dec. 29, 1913 [1]	$5.50–$5.95	July, 1917	$12.60
Mar. 30, 1914	5.50– 5.95	October, 1917	14.75
June 29, 1914	5.50– 5.95	Dec. 31, 1917	15.90
August, 1914	5.50– 5.95	Jan. 5, 1918	15.90
Oct. 1, 1914	5.70– 6.05	Apr. 1, 1918	15.90
January, 1915	5.95– 6.30	July 1, 1918	15.90
Apr. 1, 1915	5.95– 6.30	Oct. 7, 1918	15.70
July 1, 1915	5.95– 6.30	Jan. 6, 1919	15.70
Oct. 1, 1915	5.95– 6.30	Apr. 7, 1919	$13.95– 14.20
January, 1916	6.70– 7.35	July 7, 1919	13.95– 14.20
April, 1916	6.70– 7.35	Oct. 6, 1919	11.80– 11.85
July, 1916	6.70– 7.35	January, 1920	11.80– 11.85
October, 1916	6.70– 7.35	April, 1920	11.80– 11.85
January, 1917	7.95– 8.20	July, 1920	10.80– 10.90
April, 1917	12.60	October, 1920	10.80– 10.90

[1] Not quoted prior to December, 1913.

Morphine, alkaloid, bulk—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

July, 1916 [1]	$6.95	Dec. 31, 1917	$16.20
October, 1916	6.95	Jan. 5, 1918	16.20
January, 1917	$7.00– 7.30	Apr. 1, 1918	$16.10– 16.25
April, 1917	9.80	July 1, 1918	16.10– 16.25
July, 1917	9.80	Oct. 7, 1918	16.00
October, 1917	13.50	Jan. 6, 1919	16.00

[1] Not quoted prior to July, 1916.

Morphine, bulk, muriate and sulphate—Prices per ounce, wholesale, New York, spot. (5-ounce cans; 25-ounce lots.)

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$4.95–$5.05	July, 1916	$5.50–$5.60
Apr. 1, 1912	4.70– 4.80	October, 1916	5.50– 5.60
July, 1912	4.45– 4.55	January, 1917	7.00– 7.30
Sept. 30, 1912	4.20– 4.30	April, 1917	9.80
Dec. 30, 1912	4.20– 4.30	July, 1917	9.80
Mar. 29, 1913	4.20– 4.30	October, 1917	11.80
June 30, 1913	4.20– 4.30	Dec. 31, 1917	12.80
Sept. 29, 1913	4.20– 4.30	Jan. 5, 1918	12.80
Dec. 29, 1913	4.70– 4.85	Apr. 1, 1918	12.80
Mar. 30, 1914	4.70– 4.85	July 1, 1918	11.80
June 29, 1914	4.70– 4.85	Oct. 7, 1918	[1] 11.80
August, 1914	4.70– 4.85	Jan. 6, 1919	[1] 11.80
Oct. 1, 1914	5.30– 5.40	Apr. 7, 1919	[1] 10.80–11.10
January, 1915	5.00– 5.05	July 7, 1919	[1] 10.80–11.10
Apr. 1, 1915	5.00– 5.05	Oct. 6, 1919	[1] 8.80– 8.90
July 1, 1915	5.00– 5.05	January, 1920	[1] 8.80– 8.90
Oct. 1, 1915	5.00– 5.05	April, 1920	[1] 8.80– 8.90
January, 1916	5.50– 5.60	July, 1920	[1] 7.80– 7.90
April, 1916	5.50– 5.60	October, 1920	[1] 7.80– 7.90

[1] Sulphate.

Opium, derivatives and prepations of—rates of duty.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1883	122	Opium, aqueous extract of, for medicinal uses, and tincture of, as laudanum, and all other liquid preparations of opium, not specially enumerated or provided for in this act.	40 per cent ad valorem.
	123	Morphia, or morphine, and all salts thereof	$1 per ounce.
1890	35	....do	50 cents per ounce.
	47	Opium, aqueous extract of, for medicinal uses, and tincture of, as laudanum, and all other liquid preparations of opium, not specially provided for in this act.	40 per cent ad valorem.
1894	25	Morphia, or morphine, and all salts thereof	50 cents per ounce.
	35	Opium, aqueous extract of, for medicinal uses, and tincture of, as laudanum, and all other liquid preparations of opium, not specially provided for in this act.	20 per cent ad valorem.
1897	43	* * * morphia or morphine, sulphate of, and all alkaloids or salts of opium.	$1 per ounce.
		* * * aqueous extract of opium, for medicinal uses, and tincture of, as laudanum, and other liquid preparations of opium, not specially provided for in this act.	40 per cent ad valorem.
1909	41	* * * morphia or morphine, sulphate of, and all alkaloids of opium, and salts and esters thereof.	$1.50 per ounce.
		* * * aqueous extract of opium, for medicinal uses, and tincture of, as laudanum, and other liquid preparations of opinion, not specially provided for in this section.	40 per cent ad valorem.
1913	47	* * * morphia or morphine, sulphate of, and all alkaloids of opium, and salts and esters thereof.	$3 per ounce.
		* * * aqueous extract of opium, for medicinal uses, and tincture of, as laudanum, and other liquid preparations of opium, not specially provided for in this section.	60 per cent ad valorem.

For the decisions, see Opium, supra.

COCAINE.

(Par. 47. Act of 1913, $2 per ounce.)

SUMMARY.

DESCRIPTION.

Cocaine is an alkaloid derived from coca leaves. It is used chiefly as a local anesthetic in minor surgical operations, and is the most important medicinal of this class. It has other less important legitimate medicinal uses. Large quantities are used as an exhilarant by drug addicts, an illegal and vicious use which should be discouraged whenever possible. The hydrochloride is the principal salt of cocaine, and constitutes the major portion of the "cocaine" of commerce.

Ecgonine and its derivatives are alkaloidal substances occurring with cocaine in coca leaves; from them cocaine may be derived by chemical processes. They have no recognized medicinal use.

DOMESTIC PRODUCTION.

Cocaine used in the United States is practically all of domestic manufacture. Statistics are lacking, but estimates of manufacturers, and the normal quantity of cocaine obtainable from coca leaves, indicate an annual production of 100,000 or more ounces. Owing to the habit-forming properties of cocaine, a host of synthetic local anesthetics have been developed, the chief of which are discussed briefly under "General information." These were formerly chiefly imported, but under war conditions a number of German patents have been licensed to American manufacturers. While these products have attained a considerable vogue, apparently they have not decreased the demand for cocaine.

The manufacture of cocaine, like that of most alkaloids, is a specialized industry, and is chiefly carried on by a few firms. The limitations imposed by the food and drugs act, the Harrison narcotic law, and various State enactments have further tended to centralize the industry.

FOREIGN PRODUCTION.

Cocaine is produced commercially in Germany, England, and other European countries. Large amounts of crude cocaine are produced in Peru and exported chiefly to Europe for purification. Statistics of foreign production have not been available. English export statistics for the years 1911–1916 show a minimum of 5,466 ounces, valued $11,553, in 1912, and a maximum of 34,653 ounces, valued at $91,037, in 1916. Prior to the war, Germany took nearly all this product; since 1914, France has been England's chief customer. Exports to the United States are not reported separately.

IMPORTS.

Statistics of American imports by countries are not available, but the small amounts imported under the tariff of 1913 probably came chiefly from England, and prior to 1913 from England and Germany. For the year 1909 (during which cocaine was dutiable at 25 per cent) imports totaled 32,972 ounces, valued at $48,343.

On August 6, 1909, the 25 per cent duty was replaced by a specific levy of $1.50 per ounce which, for that year, represented an ad valorem rate of 88.11 per cent. From July 1 to August 6, 1909, 29,632 ounces, valued at $38,163 were imported; for the remainder of the fiscal year, 24,928 ounces, valued at $42,438, is reported. For the years 1911–1914 (the latter year to October 3 only) an average annual amount of 3,239 ounces and an average annual value of $5,174 is reported. From the imposition of the specific $2 rate through 1915, only insignificant amounts of cocaine entered the customs. Imports of 1916 and 1917, reflecting war conditions, rose to 4,275 ounces and 19,388 ounces, respectively.

While definite data are lacking, it is believed that American cocaine imports consist largly of rare salts which are not manufactured in this country.

REVENUES.

The revenues yielded by cocaine have never been large. For the period 1909–1917 they reached a maximum of $46,933 in 1909; since then they have reached $10,000 only in 1917, when they amounted to $38,776.

PRICES.

Import values of cocaine preparations have varied from $1.25 per ounce in 1914, to $2.36 in 1915. For the last reported year (1917) $1.99 is given.

The American wholesale market regularly quotes cocaine hydrochloride only. From a prewar value of $2.60 to $3.10 per ounce in 1914, it has risen steadily to $11 to $11.50 in December, 1918.

Cocaine, a comparatively recent introduction to trade, was first specifically mentioned in the act of 1909. Prior to this date (under the acts of 1883–1897) the proper classification of cocaine and its various compounds was the cause of considerable litigation, and these drug products were variously held to be medicinal compounds, in the preparation of which alcohol had been used; alkaloids; and chemical compounds and salts. Upon the adoption of the act of 1909, the moral dangers attending the promiscuous use of cocaine were recognized, and this drug, like opium preparations, was placed on a supposedly prohibitive basis at $1.50 per ounce, which corresponded during the life of the act to ad valorem rates ranging from 71.04 to 120.34. The act of 1913, imposing the $2 rate, raised the ad valorem to 161.32, but by 1917 it had dropped to 100.39, and imports had increased almost fivefold over the preceding year.

TARIFF QUESTIONS INVOLVED.

The high duties imposed by the two last tariff acts have been due to the movement to suppress cocainism. The resulting protection to American manufacture has been secondary to the intent to keep

this easily abused drug out of illegitimate channels. The intent of Congress, as evinced in tariff laws and other legislation, has been to localize the manufacture of cocaine in the hands of a few repsonsible parties, and to restrict its distribution from these known sources by appropriate legislation, which latter of course is beyond the purview of tariff law.

General Information.

Cocaine is an alkaloid ($C_{17}H_{21}O_4N$) obtained from *Erythroxylon coca* Lamarck and its varieties (family Erythroxylaceae).

The term "cocaine" in common language includes both the alkaloid and its salts.

Sources of supply.—Coca leaves, from which cocaine is extracted, come chiefly from Peru and Java. The cocaine used in the United States is practically all of domestic manufacture. Cocaine is also manufactured in England and Germany, and a crude cocaine extracted in Peru is largely exported to other countries for purification. Henry citing the Chemist and Druggist, 1912, page 51, gives the annual export of crude cocaine from Peru as 6,000 kilograms (13,200 pounds). Statistics of domestic production have not been collected, but an approximate estimate may be derived from importations of coca leaves, which are used almost wholly for extraction of the alkaloid. The standard of ether soluble alkaloid content of coca leaves was fixed by the United States Pharmacopœia, VIII, at 0.5 per cent; while this includes other alkaloids than cocaine, these may by appropriate treatment be transformed into cocaine, and for practical purposes may be reckoned as such. Reckoning the cocaine content at 0.5 per cent, the coca leaves imported in the years 1913–1917 would be sufficient for the manufacture of about 72,300 ounces annually. The actual amount is probably somewhat in excess of this, as the alkaloid content of the leaves is not infrequently considerably above the amount above stated, and modern processes of extraction have reached a high degree of efficiency.

History of cocaine.—Cocaine was discovered in 1855, but attracted little attention in pharmacology or therapeutics until about 1880. The introduction of cocaine as a practical local anesthetic is mainly due to Koller (1884). For many years its use was practically limited to local operations in the nose or throat and to ophthalmic surgery. Within the last few years, however, its use has been widely extended; numerous major surgical operations have been performed under it, and local anesthesia by means of cocaine is now a rival of general anesthesia under ether and chloroform. Its toxic action and habit-forming tendencies have limited its use, however; the latter character, especially in cases where repeated administration is necessary, a considerable period of time. It has in part been replaced by a number of substitutes which will be referred to again. The abuse of cocaine has become so widespread in recent years as to lead to the limitation of its sale by the food and drugs act, the Harrison narcotic law, and various State enactments. To this abuse also may be traced the high duties placed by recent tariffs on coca leaves and cocaine.

Cocaine also has gained considerable notoriety as an ingredient of so-called "drug cures" and "opium-habit cures," owing largely to the attention called to this abuse in China. The international opium

convention signed at The Hague in 1912 binds the contracting powers to "use their best endeavors" to adopt measures to restrict the manufacture and sale of cocaine and its salts.

Preparation.—Cocaine, chemically, is methyl-benzoyl-ecgonine, ecgonine being a substance which does not occur free, but may be obtained by hydrolysis of the chief coca alkaloids.

Numerous processes have been proposed for the extraction and preparation of cocaine, and those actually in use probably vary somewhat in each factory. By Squibb's process the ground leaves are exhausted by repercolation with 5 per cent sulphuric acid and the extract agitated with pure coal oil (kerosene) and an excess of sodium carbonate. The alkaloid is taken up by the coal oil, whence it is recovered by acidulated water and again precipitated by sodium carbonate in the presence of ether. Crystalline cocaine is obtained upon distillation of the ether, and is dissolved in acidulated water, decolorized with animal charcoal, again precipitated by sodium carbonate, and dissolved in and recrystallized from ether or hot alcohol.

By Bignon's process the powdered leaves are extracted with a mixture of aqueous sodium carbonate and petroleum; the alkaloids are taken up in the petroleum, which is drawn off and treated with dilute hydrochloric acid. Crude cocaine hydrochloride is obtained as a crystalline precipitate, and a second amount may be obtained by evaporation. Cocaine is purified as the hydrochloride by liberating the base and dissolving this in alcoholic hydrochloric acid and recrystallizing.

In both processes a variable amount of amorphous alkaloids are retained in the mother liquors; these are in the main or wholly ecgonine derivatives, and are treated in various ways for conversion into cocaine. In one method the solutions are concentrated and hydrolized by heating with hydrochloric acid. Certain insoluble acids produced by the hydrolysis are precipitated by the addition of water, and ecgonine hydrochloride is obtained by evaporation of the filtrate on the addition of alcohol and ether. The ecgonine is set free and digested with a molecular quantity of benzoic anhydride, after which the excess of benzoic anhydride and benzoic acid is removed by ether, leaving benzoyl-ecgonine and a small quantity of unattacked ecgonine. Ecgonine is removed by solution in water, and the benzoyl-ecgonine boiled with methyl iodide, potassium hydroxid, and methyl alcohol, whereupon cocaine is formed, and may be purified as above described. According to Merck, ecgonine may be converted into cocaine in one operation by heating with methyl iodide and benzoic anhydride under pressure.

Java coca leaves are now much used for the preparation of cocaine. Cinnamyl cocaine is the chief alkaloid of these leaves, and the total alkaloids are treated by processes similar to those just described for the amorphous alkaloids.

Of the several other alkaloids of cocaine, none is in itself of interest save tropacocaine, which will be noticed again under cocaine substitutes.

Uses of cocaine.—Cocaine is official in most pharmacopœias. The hydrochloride is the salt most commonly used and is also official. Numerous other salts and combinations have had more or less vogue.

Cocaine is used as a local anesthetic, as a local vasoconstrictor, to dilate the pupils of the eye, as a respiratory stimulant, as a cir-

culatory stimulant, and as a general tonic. It is chiefly valued as a local anesthetic in surgical work. In this connection it is sprayed on mucous membranes or injected subcutaneously. As the oleate stearate, cocaine is used in ointments and suppositories.

As a vasoconstrictor cocaine is used in both acute and chornic affections of the mucous membranes, especially of the eye and nose. It has formed a frequent ingredient of catarrh powders, hay-fever remedies, etc., of the proprietary type. Its use in these connections has been somewhat curtailed by legislation. As a vasoconstrictor cocaine has been largely superseded by preparations of the suprarenal glands.

As a stimulant to the respiratory center cocaine is considered to rank second only to strychnine, and is of particular value in treatment of various narcotic poisonings. Thus it has been used in treatment of morphinism, especially in proprietary "cures," but its routine administration leads to a worse habit than the first.

As a general circulatory stimulant it is rarely used save as a supplement to other therapeutic agents, and as a general tonic its use is usually indefensible.

Cocaine has been a most dangerous ingredient of proprietary remedies, especially of "asthma remedies," catarrh "cures," tobacco and drug habit "cures," etc. It has also been used as an ingredient in certain soft drinks, as a "lacing" for liquor, and in "alcohol tablets" sold in "dry" communities for the preparation of stimulants.

Cocainism.—Cocainism is somewhat analogous to morphinism, but develops even more rapidly. Cocaine produces an intense exhilaration, a kind of temporary insanity in which the moral sense is obliterated. Mania, epileptiform convulsions, insomnia, hallucinations, and melancholia are frequent symptoms. Physical effects are digestive disturbances, debility, emaciation, anemia. The habit is one of the most quickly established of all drug addictions, and by many authorities is considered the worst of its class. It is especially prevalent among the lower classes, especially among criminals and Negroes. A large proportion of crimes committed by Negroes in the South are attributed to cocaine. At hearings held before the Committee on Ways and Means of the Sixty-first Congress (H. R. 25241) the amount of cocaine used for vicious purposes was estimated by various witnesses at from 75 to 90 per cent of the total domestic output.

Cocaine substitutes.—The chief disadvantages of cocaine, its instability, its toxic properties, and the danger of habituation have led to the introduction of numerous substances designed as substitutes. These have been largely of the "ethical proprietary" type, and, while many possess advantages for certain purposes, it may be generally stated that cocaine, properly used, is still the best anesthetic of its class. Statements of the relative value and qualities of this class of substances disagree widely. Numerous preparations have been introduced, of which the following are of chief importance:

Tropococaine.—This alkaloid is found in small quantities in Java coca leaves, and is also obtained synthetically. It is said to be half as toxic as cocaine, and is used chiefly in spinal anesthesia.

Betaeucaine.—This is a synthetic derivative of piperidine. Its hydrochloride is official. Alpha and beta eucaine were among the

first cocaine substitutes to be put on the market; the first has disappeared from use. As a local anesthetic it is almost as efficient as cocaine, but often induces irritation. It is stable on sterilization, and is especially used in ophthalmology. The lactate has recently been introduced, and is claimed to have some advantages over the hydrochloride.

Stovaine.—This is an artificial alkaloid, recently introduced, less toxic than cocaine and nearly equal to it in anesthetic action; it occasionally causes collapse.

Alypine is closely related to stovaine. The evidence regarding its value is rather conflicting. According to Cushing, its use is attended by marked irritant congestion and even sloughing.

Orthoform-new and orthoform-new hydrochloride are local anesthetics used chiefly on raw surfaces and on gastric and other ulcers; orthoform-new is practically insoluble and not adapted for hypodermic use. The original closely related compound known as orthoform has been withdrawn from the market in favor of these.

Novocaine and novocaine nitrate are said to be the least toxic of the cocaine substitutes, but the anesthetic effect is very transient; this defect is said to be remedied by the simultaneous injection of epinephrine. Novocaine is now (1918) licensed for American manufacture as "*procaine*" under the trading with the enemy act. Anaesthesin, propaesin, and cycloform are closely related substances, esters of amino-benzoic acid. Their toxicity is relatively low, and their uses largely the same as orthoform-new.

Holocaine is a condensation product of acetphenetidin and paraphenetidin. It appears to exceed cocaine in anesthetic power and is also said to be more toxic. Its only apparent advantage lies in its active germicidal power.

Cocaine and cocaine salts—Exports—England (fiscal years).

[Source: Annual Statement of Trade of the United Kingdom. Exports of foreign and colonial merchandise.]

Exported to—	1911[1]		1912		1913		1914	
	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.
Germany	27,778	$36,888	3,150	.....	20,152	.....	10,750	.....
All other	200	414	2,296	.....	3,496	.....	1,246	.....
Total	27,978	37,302	5,446	$11,553	23,648	$29,350	11,996	$10,823

Exported to—	1915		1916		1917		1918	
	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.
France	3,315	$4,161	19,882	$44,869	7,271	$22,576	366	$2,093
All other	4,829	9,212	14,771	46,168	1,818	10,696	1,371	17,213
Total	8,144	13,373	34,653	91,037	9,089	33,272	1,737	19,306

[1] Prior to 1911 under "Drugs, unenumerated."

Cocaine, ecgonine, and salts and derivatives—Imports for consumption—Revenue.

[Par. 47, act of 1913.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Ounces.*				*Per cent.*
1909	25 per cent	32,272	$48,343	$12,085	$1.50	25.00
1910	do	29,632	38,163	9,540	1.29	25.00
1910 [1]	$1.50 per ounce	24,928	42,438	37,392	1.70	88.11
1911 [2]	do	4,031	8,366	6,046	2.08	71.94
1912	do	2,004	3,499	3,006	1.75	85.91
1913	do	3,715	4,835	5,573	1.30	115.25
1914 [3]	do	3,205	3,995	4,807	1.25	120.34
1914 [4]	$2 per ounce	85	106	171	1.25	161.32
1915	do	179	422	358	2.36	84.83
1916	do	4,275	5,887	8,550	1.37	145.23
1917	do	19,388	38,627	38,776	1.99	100.39
1918	do	8,597	35,358	17,194	4.11	48.63
1919	do	19,382	68,584	38,764	3.54	56.52
Calendar year—						
1918		18,389	80,652	36,778	4.38	45.60
1919		12,464	29,035	24,928	2.32	85 86
1920 [5]	$2 per ounce	7,174	18,681	14,348	2.60	76.80

[1] Act of 1897, July 1 to Aug. 5, 1909.
[2] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909, July 1 to Oct. 3, 1913.
[4] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[5] Six months ending June 30, 1920.

Cocaine, hydrochloride, crystals—Prices per ounce, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Dec. 29, 1913	[1] $2.60–$2.85	January, 1917	$4.25–$4.50
Mar. 30, 1914	2.60– 3.60	April, 1917	5.50– 5.75
June 29, 1914	2.60– 3.10	July, 1917	7.25– 7.50
August, 1914	2.60– 3.10	October, 1917	8.00– 8.50
Oct. 1, 1914	5.00– 6.00	Dec. 31, 1917	9.00
January, 1915	4.00– 4.25	January, 1918	9.25
April, 1915	3.50– 3.75	April, 1918	9.25
July, 1915	3.50– 3.75	July, 1918	11.25–11.50
October, 1915	3.50– 3.75	October, 1918	11.25–11.50
January, 1916	3.50– 3.75	January, 1919	11.25–11.50
April, 1916	4.25– 4.50	April, 1919	[2] 9.75–10.00
July, 1916	4.25– 4.50	July, 1919	[2] 9.75–10.00
October, 1916	4.25– 4.50	October, 1919	[2] 9.75–10.00

[1] Not quoted prior to December, 1913.
[2] Crystals, granular and powdered.

Cocaine, hydrochloride, granular—Prices per ounce, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Jan. 5, 1918	[1] $9.00	Jan. 6, 1919	$11.00–$11.25
Apr. 1, 1918	9.00	Apr. 7, 1919	[2] 9.50– 9.75
July 1, 1918	$11.00–11.25	July 7, 1919	[2] 9.50– 9.75
Oct. 7, 1918	11.00–11.25	Oct. 6, 1919	[2] 9.50– 9.75

[1] Not quoted prior to 1918.
[2] Flasks.

Cocaine—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1909	41	* * * Cocaine, ecgonine, and all salts and derivatives of the same..	$1.50 per ounce.
1913	47	* * * Cocaine, ecgonine, and all salts and derivatives of the same.	$2 per ounce.

For decisions, see Opium, supra.

UNITED STATES TARIFF COMMISSION

WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPH 46 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

ESSENTIAL AND DISTILLED OILS

Paragraph 46:

- Almond, Bitter. (See par. 45.)
- Amber
- Anise seed
- Aspic or Spike Lavender
- Bergamot
- Camomile
- Cassia
- Cinnamon
- Caraway
- Cedrat
- Citronella
- Fennel
- Eucalyptus n. s. p. f.
- Jasmine
- Juniper
- Lavender
- Lemon Grass
- Limes

Paragraph 46—Continued:

- Lemon
- Mace
- Neroli
- Nutmeg
- Orange
- Origanum
- Peppermint
- Rose or Attar of Rose
- Rosemary
- Thyme
- Valerian

Paragraph 561:

- Birch Tar
- Cajeput
- Ichthyol
- Juglandium

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U.S. Tariff Com.
6-4-28

PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Sidney D. Kirkpatrick and E. E. Stanford of the chemical division of the Commission's staff, and of others.

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ESSENTIAL AND DISTILLED OILS.

[Par. 46, act of 1913.]

INTRODUCTION.

PAR. 46. Oils, distilled and essential: Orange and lemon, 10 per centum ad valorem; peppermint, 25 cents per pound; mace oil, 6 cents per pound; almond, bitter; amber; ambergris; anise or anise seed; bergamot; camomile; caraway; cassia; cinnamon; cedrat; citronella and lemon-grass; civet; fennel; jasmine or jasimine; juniper; lavender and aspic or spike lavender; limes; neroli or orange flower; origanum, red or white; rosemary or anthos; attar of roses; thyme; and valerian; all the foregoing oils, and all fruit ethers, oils, and essences, and essential and distilled oils and all combinations of the same, not specially provided for in this section, 20 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

PAR. 561. Oils: Birch tar, cajeput, * * * ichthyol, juglandium, * * *. (Free list.)

Paragraph 46 of the act of 1913 includes provisions for essential and distilled oils of *ambergris* and *civet*. No such articles are known to commerce or to science. Ambergris and civet are perfume materials of animal origin and are provided for specifically in paragraph 49. Paragraph 561 includes provision for oil of *juglandium*. There is no oil in commerce by this name, although the term probably refers to walnut-leaf oil (from *juglans regia*) which, however, is of no commercial importance and, therefore, not included in this report.

DEFINITION.

The volatile, essential, distilled, or ethereal oils constitute an extensive class of organic substances, which in general possess in a concentrated form the characteristic odor and taste of the plants and other vegetable products from which they are derived. The term is also applied to synthetic products, identical with or closely related to the natural oils. "Volatile" and "ethereal" refer to the fact that the oils are readily vaporizable, rather than to their method of preparation, which is usually by a distillation process. "Essential" is derived from *essence*, which is used by the French to refer to "the quality on which an object depends for being what it is." In the United States, however, the term "essence" is often used to refer to alcoholic solutions of the essential oils.

Umney is authority for the statement that—

> A scientific definition of the term "essential" or volatile oil is not possible, but (that) they may be for general purposes defined as substances of an oily nature obtained from, as a rule, vegetable sources, possessed usually of odor, generally liquid, although sometimes semisolid at ordinary temperatures, and volatile without decomposition.

CLASSIFICATION AND CONSTITUTION.

Because of their widely divergent character, it is extremely difficult, if not impossible, to prepare a logical classification of essential

oils based on their chemical constitution. For this reason they are usually grouped on the basis of the botanical classification of the plants from which they are derived. This method of classification is used by Parry and by Gildermeister and Hoffman.

The principal chemical constituents of the essential oils are as follows:

1. *Hydrocarbons* and *terpenes*, such as pinene in turpentine and cumene in oil of thyme.
2. *Ketones*, such as camphor in camphor oil, irone in oil of orris root, and caravone in oil of caraway.
3. *Phenols*, such as eugenol in oil of cloves, thymol in thyme oil, and anethol in anise oil.
4. *Aldehydes*, such as citral and citronellal in lemon and lemon-grass oils, cinnamic aldehyde in oil of cassia, and benzaldehyde in oil of bitter almonds.
5. *Alcohols*, such as geraniol in rose and geranium oils, borneol in rosemary and camphor oils, and eucalyptol in eucalyptus oil.
6. *Esters*, such as methyl salicylate in oil of wintergreen, and methyl anthranilate in oil of neroli.
7. *Nitrogen compounds*, such as indol in oil of jasmine.

Description and Uses.

General.—Most of the essential oils are colorless or pale yellow liquids, with strong and penetrating aromatic odors and bitter, balsamic taste. They are easily volatilized, usually without decomposition, are practically all insoluble in water, but dissolve readily in alcohol, ether, chloroform, and other volatile solvents.

Essential oils are used chiefly in the preparation of flavoring materials and perfumery. A number of them possess therapeutic properties and are used either alone or with other materials in compounding various medicinal preparations. Others are often added to medicines to mask disagreeable odor or taste or to correct other undesired effects. Certain of the volatile oils, such as origanum, thyme, cinnamon, cassia, and cloves, possess germicidal properties. Their high cost precludes their general use for disinfecting purposes, but they are often used in special applications such as for the mouth and nostrils.

More detailed information in regard to the nature of the individual oils and their principal uses is shown in the table which accompanies this report and in the discussions under "General information for individual oils," *infra*.

Adulteration.—The essential oils are commonly sophisticated, notwithstanding the fact that a great deal of attention has been given to their analysis and the detection of adulterants. Among the cruder materials which are often used for adulteration are turpentine, alcohol, chloroform, fatty or expressed oils, and petroleum. Adulteration more difficult to detect consists in adding various synthetic constituents of similar chemical composition to those occurring in the natural oil. Oftentimes these are so skillfully prepared as to render detection almost an impossibility. Another form of modern sophistication consists in diluting the pure oil with a cheaper volatile

oil or with the terpenes or similar valueless fractions obtained in the manufacture of other more concentrated products.

Empiric tests are often of little value and in many instances a product must be judged solely by its odor or the knowledge of its origin and preparation.

Production and Trade.

History[1].—The trade in plant products and aromatic drugs dates back to prehistoric time. Although the Egyptians were probably familiar with general principles of distillation, it remained for the Arabians, many centuries later, to perfect the process and use it as a means of securing the active constituents from drugs and other vegetable materials. Avicenna, an Arabian physician of the tenth century, first produced rose water and rose oil (attar of roses) by steam distillation, the process still used for the preparation of this and many other essential oils.

According to Gildermeister, the following essential oils were known and in use at the beginning of the sixteenth century: Benzoin, calamus, cedarwood, costus root, mastix, rose, rosemary, sage, spike, turpentine, juniperwood, frankincense, and cinnamon.

The sixteenth and seventeenth centuries were a fruitful period of investigation in this field, and yielded many important discoveries. The following are the dates when the other essential oils discussed in this report were first recognized in commerce:

1500–1540: Anise, cardamom, caraway, fennel, mace, nutmeg, and juniper berries.

1540–1589: Amber, asafetida, thyme, origanum, chamomile (German and Roman), and sassafras.

1672–1708: Valerian.

1708–1730: Cajeput.

Fewer discoveries have been made since the middle of the eighteenth century, although the industry as a whole has undergone rapid development. Most progress has been made in the scientific study of the constitution and properties of the individual oils, and at the same time their methods of preparation have been constantly improved and modified.

Methods of production.—The essential oils are usually obtained from the flowers and fruit of the different plants, although they are often contained in the roots, bark, leaves, and seeds, or are distributed throughout the entire plant. Certain plants yield more than one essential oil, as in the case of orange oil prepared from orange peel, and oil of neroli, from orange flowers. Oils of mace and nutmeg are prepared from different parts of the fruit of the same tree.

The methods of producing essential oils are usually divided into three general classes: (1) Distillation of the flowers, herbs, seeds, barks, leaves, or resins; (2) mechanical processes; and (3) extraction by solvents.

(1) *Distillation* is by far the most important process for obtaining the essential oils. In general this consists in passing steam through the material and on into a condenser where, on cooling, a separation of the oil and water takes place.

[1] An exhaustive study of the history of the essential oils is given in "The Volatile Oils," by Gildermeister and Hoffman, pp. 1–100.

Many of the oils are still prepared in primitive stills by the unskilled natives, and by methods no different from those used centuries ago. The material to be distilled is immersed in water in small vessels, holding only 10 to 50 gallons, which are usually heated over an open fire. The process nearly always yields an oil inferior in quality because portions of the plants are apt to adhere to the bottom of the still and become scorched, or the hot water used in the process may saponify the oil and contaminate its odor. Modern methods of distillation, which are fortunately replacing these primitive processes, increase the yield of oil and give a better and more uniform product. The large stills hold thousands of gallons and are heated on the outside by steam jackets or from within by closed steam coils. A current of steam is also passed into the stills under various degrees of pressure. In many cases distillation under diminished pressures and, accordingly, at a lower temperature, avoids the partial decomposition of the oil and therefore results in a superior product.

(2) *Mechanical processes.*—The essential oils prepared from the peel or rind of the citrus fruits are usually obtained by a form of hand or machine expression. In Sicily, orange and lemon oils are prepared entirely by hand by the "sponge process," which consists in pressing the oil out of the peel and into a sponge. Bergamot oil is usually expressed in small machine presses operated by hand. Oil of limes is prepared in the West Indies by the "écuelle process," which consists in pressing the rinds against the spiked bottom of a small copper vessel held between the knees of the operator. In California and in Florida, orange and lemon oils are prepared from cull fruit, which are shredded in machines and from which the juice and oils are removed by presses. The juice and oils are separated in a centrifugal machine. (See Tariff Information Survey unit for citrus oils.)

(3) *Extraction processes* are employed for the preparation of delicate floral oils, which would be decomposed by the heat or the steam employed in the distillation process. A volatile solvent, such as alcohol, benzine, petroleum ether, carbon disulphide, or chloroform, is passed through a layer of the flowers or other materials, and dissolves out the essential oil, together with resins, waxes, coloring matters, and other soluble substances. The essential oils (with the impurities) are separated from this mixture by distilling off the solvent. The so-called "flower concretes" and "absolute floral essences" are prepared by again extracting the oils thus obtained with alcohol and evaporating off the solvent. (See Tariff Information Survey for enfleurage greases and floral essences, par. 49.)

A modification known as the "moist-air" process also makes use of a volatile solvent. In this process the heated air is passed through a series of wet sponges, then over the flowers, and finally into the solvent. The solvent retains the odorous principles and is afterwards removed, leaving a perfume which contains only the pure oil and no coloring matter nor resin.

The "maceration" and "enfleurage" processes are used principally for the preparation of the flower pomades and concretes. The former process consists in macerating the flowers in a warm oil or fat, such as purified lard. After the fat has absorbed the odor the spent flowers are removed, a fresh lot added, and the process repeated until a pomade of the desired strength is obtained. This process is exten-

sively used for rose, violet, orange, and cassia flowers. The enfleurage process (enfleurage à froid) is carried out at room temperature, for even the slight heat of the maceration process is sufficient to destroy the odorous constituents of certain very sensitive materials. The flowers are placed on wire netting and a glass plate covered with a heavy fat or oil is suspended directly over the flowers. The flowers and plates are placed in alternate layers and are allowed to stand for several days. The flowers are then removed, fresh flowers added, and the process repeated until the fat has become saturated with the volatile oils. The saturated fat, or flower "pomade," as it is called, is washed with alcohol, which extracts most of the odorous substances, although enough is retained by the fat to make it a valuable material for the manufacture of perfumed toilet soaps. The enfleurage process is used largely in southern France for the preparation of the essential oils of jasmine and tuberose. (See "Enfleurage greases," par. 49.)

Domestic production.—The domestic production of essential oils is comparatively small. The Census of Manufactures states that in 1914 the domestic production of essential oils was valued at $1,289,482. Over 50 per cent of this, however, was represented by peppermint oil, while spearmint, black birch, wintergreen, and wormwood oils accounted for an additional 25 per cent. The remaining production (to the value of $348,522) was made up of sassafras, cedar, pennyroyal, tansy, sandalwood, camphor, cloves, parsley, patchouli, lemon, and orange oils.

Foreign production.—France is by far the most important producer of essential oils as well as the other natural perfume materials. Italy, because of her enormous output of the citrus oils, probably occupies the position of next importance. Considerable quantities of the essential oils are also obtained from Germany, Spain, East and West Indies, and from the French and British colonies. In general, statistics for the production of essential oils in these countries are not available, although in the case of certain of the oils this information is included in the detailed discussion which follows.

Tariff History.

The act of 1883 includes the following provision: "All preparations known as essential oils, * * * distilled oils, * * * and all combinations of any of the foregoing, 25 per centum ad valorem." Fruit ethers, oils, and essences were dutiable at $2.50 per pound, which rate in 1890 was equivalent to 328 per cent ad valorem. Many of the oils discussed in this report, however, were mentioned specifically on the free list, which contained provisions for the oils of amber, ambergris, anise or anise seed, cajeput, caraway, cassia and cinnamon, camomile, civet, fennel, jasmine or jasimine, juniper, mace, rosemary or anthoss, thyme or origanum, and valerian.

In the act of 1890 these provisions remained practically unchanged. In 1894 the specific duty on fruit ethers, oils, and essences was reduced to $2 per pound and the new duty in 1896 was equivalent to an ad valorem rate of 129 per cent. The act of 1897 added the provision—

Provided, That no article of this paragraph shall pay a less rate of duty than 25 per centum ad valorem.

In the act of 1909 the duty on fruit ethers, oils, and essences was further reduced to $1 per pound, which rate in 1913 corresponded to 99.06 per cent ad valorem.

Under the act of 1913 all of the essential and distilled oils, with the exception of birch tar, cajeput, juglandium, and ichthyol, became dutiable under paragraph 46. Orange and lemon oil became dutiable at 10 per cent ad valorem, mace oil received a duty of 6 cents per pound, peppermint oil a duty of 25 cents per pound, and a uniform rate of 20 per cent ad valorem was provided for the other essential oils as well as "all fruit ethers, oils, and essences, and essential and distilled oils and all combinations of the same, not specially provided for in this section." The additional provision "*Provided*, That no article containing alcohol shall be classified for duty under this paragraph" was added in order to prevent conflict with paragraph 16, which provides for alcoholic solutions of all essential and distilled oils, fruit essences, and ethers. Oils of birch tar, cajeput, ichthyol, and juglandium were mentioned specifically in paragraph 561 of the free list.

TARIFF CONSIDERATIONS.

Competitive situation.—The natural essential oils are in most cases articles of foreign origin, not produced in the United States nor competitive with articles of domestic manufacture.

Essential and distilled oils are chiefly used in the manufacture of flavors and perfumery, while a few possess therapeutic properties and are used in medicines. In this connection it is of interest to consider the duty imposed by the act of 1913 on the principal finished products, which are as follows:

Flavoring extracts containing 20 per cent or less of alcohol, 10 cents per pound and 20 per cent ad valorem; containing more than 20 per cent of alcohol and not more than 50 per cent, 20 cents per pound and 20 per cent ad valorem; and containing more than 50 per cent of alcohol, 40 cents per pound and 20 per cent ad valorem. (Par. 16.)

Perfumery, toilet waters, and cosmetics, if alcoholic, 40 cents per pound and 60 per cent ad valorem, and if nonalcoholic, 60 per cent ad valorem. Floral waters (nonalcoholic), 20 per cent ad valorem. (Par. 48.)[1]

Perfume materials: Mixtures and preparations used in the manufacture of perfumery (nonalcoholic), 20 per cent ad valorem. (Par. 49.)

Perfumed toilet soaps, 30 per cent ad valorem. (Par. 66.)

Revenue.—The imposition of a duty in the act of 1913 on practically all of the essential oils was presumably for the purpose of raising revenue and, as may be noted in the following table, the total revenue obtained from the imports of the essential and distilled oils has increased from $186,064 in 1910 to $705,777 in 1918:

[1] In addition to these duties, under the act of 1913 the following taxes and additional duties are assessed on imported perfumery: (1) 45 per cent ad valorem on the bottles or containers used (par. 84, act of 1913); (2) $1.10 per wine gallon or fraction thereof on all perfumes containing distilled spirits. (Sec. 610, par. c, revenue act of 1918.)

Total imports of essential and distilled oils entered for consumption in the United States, 1910–1919.

Fiscal year.	Entered free of duty.	Dutiable.	Revenue.
1910	$1,483,394	$634,708	$186,064
1911	1,768,944	777,070	245,228
1912	2,664,977	948,168	234,931
1913	3,929,094	976,063	242,001
1914	859,979	2,157,258	364,244
1915	62,921	2,738,577	471,923
1916	36,572	2,860,283	524,055
1917	54,009	3,472,890	614,421
1918	59,404	3,888,655	705,777
1919	52,282	3,625,753	[1] 700,000

[1] Estimated.

The bulk of the revenue prior to 1914 was obtained from the imports classified as "all other distilled and essential oils" and as "orange oil," both of which were dutiable at 25 per cent ad valorem. Under the act of 1913, the imports of essential oils entered free of duty fell from nearly $4,000,000 in 1913 to less than $60,000 in the years 1916, 1917, 1918, and 1919. Notwithstanding the fact that the rate of duty on "all other essential and distilled oils" was reduced from 25 per cent to 20 per cent by the act of 1913, the revenue yielded by this classification increased from $102,613 in 1908 to $242,816 in 1919. The revenue from orange oil, however, has fallen from $73,786 in 1911 to $33,050 in 1918, although the imports more than doubled during this period. Orange oil, lacking specific mention in the act of 1909, was classified as a fruit oil and dutiable at $1 per pound during 1910 and 1911, but under a Treasury decision rendered in 1912 (G. A. 7239, T. D. 31718) imports of orange oil were classified under the "all other essential and distilled oils" provision—dutiable at 25 per cent. The act of 1913 reduced this to 10 per cent. Lemon oil, one of the essential oils imported in very large quantities, was also made dutiable at 10 per cent by the act of 1913, although double this rate, or 20 per cent ad valorem, was provided for the closely related citrus oils of limes and bergamots.

Classification.

Paragraph 46 provides for "Oils, distilled and essential." Since amber oil is a distilled but not an essential oil, and since the citrus oils are essential but not distilled oils, it would seem advisable to change the phrase "Oils, distilled *and* essential," to read "Oils, distilled *or* essential."

Paragraph 46 enumerates essential and distilled oils of ambergris and civet, but since no such articles are known to commerce, the provisions should logically be omitted. The same is true of the provision of "oil of juglandium" in paragraph 561 of the free list. The term "anthoss" used in connection with rosemary oil is obsolete in present-day commerce and might well be omitted.

Some of the essential oils specifically enumerated in this paragraph are no longer of any importance in the trade, while there are several

oils, not mentioned specifically, which are imported in large quantities. The provisions for amber, mace, valerian, cedrat, and camomile oils could well be abandoned and provisions added for eucalyptus, vetiver, patchouli, petitgrain, sandalwood, ylang-ylang, and geranium and geranium rose.

The term "fruit ethers" used in paragraph 46 refers to products which are chemically "esters" and not "ethers," although in the older nomenclature they were incorrectly known as such. Reference should be made to the Tariff Information Survey on flavoring extracts in paragraph 49.

ESSENTIAL OILS OF CITRUS FRUITS.

SUMMARY.

The citrus essences of lemon, orange, bergamot, limes, cedrat, and neroli, or orange blossoms, were mentioned specifically in the free list of the tariff acts of 1883, 1890, 1894, 1897, and, with the exception of oil of orange, in the act of 1909. In the absence of specific provision, imports of orange oil were held dutiable under the general provisions. In the act of 1913 a rate of 10 per cent ad valorem was provided for lemon and orange oil, and the other citrus oils became dutiable at 20 per cent.

The essential oils of the citrus fruits are obtained by expression from the fresh peel of the ripe fruit. They are sometimes known as Messina oils, since this port is the center of the important Sicilian citrus industry. These oils in the approximate order of their importance are: Lemon, orange, bergamot, limes, neroli, and cedrat. Oils of lemon, orange, and limes are occasionally prepared by distillation processes, but the products thus obtained are usually considered inferior for most purposes. Oil of neroli is the distilled oil of orange blossoms.

All of the citrus oils are used in flavors and perfumes. Extracts of lemon and orange are common flavors used by the housewife, and are also used in confections and soft drinks. Refined grades of these oils, known as the "terpeneless" oils, are of considerably more value, since their flavoring properties have been increased by the removal of a large portion of their inert constituents.

Italy leads the world in the production of citrus oils, and supplies at least 75 per cent of the world's trade in these articles. During 1918 she exported 3,500,000 pounds of lemon, 2,000,000 of bergamot oil, and 700,000 pounds of orange oil. The United States and the United Kingdom together account for 90 per cent of the total Italian exports. Oil of limes and some orange oil are obtained from the West Indies. The neroli industry is centered in southern France.

Lemon and orange oils are the only citrus oils manufactured commercially in the United States. In comparison with the Italian industry, however, their production is on an extremely small scale. The domestic output of lemon oil in 1917 was only about 1 per cent of the imports, and the production of orange oil was even less.

The imports of the citrus oils represent about one-third of the total imports of all essential and distilled oils. Lemon oil is imported in the largest quantity; for the period 1915–1919 imports averaged 494,613 pounds, valued at $434,734. Orange oil imports in 1918

were about 200,000 pounds, valued at $330,000. Oil of bergamot is of next importance, and in recent years its imports have averaged about 60,000 pounds, worth in the neighborhood of $200,000. Oil of neroli imports in recent years have varied between 10,000 and 38,000 pounds, and the value per pound has varied from $10.50 in 1908 to $1.93 in 1916. Imports of oil of limes have shown even more variation. Maximum imports in recent years were received in 1918 and were valued at $73,000 Cedrat oil is occasionally imported, but in small amounts.

With the exception of the relatively small domestic output of lemon and orange oils, the United States does not produce products directly competitive with the imported oils. Production of these oils in the United States has been limited chiefly by two factors, viz, labor and raw materials. The large amount of labor required for hand pressing the oils has made it impossible to prepare these products by the same method as cheaply in this country as abroad. It has been hoped that machine processes might be developed which would entirely replace the hand methods, but the processes now in use involve a final distillation which yields an oil generally considered inferior to the hand-pressed product.

The citrus oils can be prepared profitably only from "culls" or inferior grades not suitable for sale as fresh fruit. In the United States, however, more scientific methods of citrus culture produce a considerably smaller proportion of culls than is ordinarily obtained in Sicily, and it is therefore doubtful if the domestic by-product industry could ever be developed to such an extent as to supply the entire American demand.

General Information.

Oil of lemon, oil of orange, oil of neroli or orange flowers, oil of bergamot, oil of limes, and oil of cedrat or citron:

PROVISIONS IN TARIFF ACT OF 1913.

46. Oils, distilled and essential: Orange and lemon, 10 per centum ad valorem; * * * bergamot; * * * cedrat; * * * limes; neroli or orange flower; * * * 20 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

DESCRIPTION AND USES.

A number of the varieties of citrus fruit contain volatile oils of commercial importance. Most of these are obtained by expressing the rinds of the fresh fruit; occasional quantities of some of the oils are obtained by distillation, but in general the distilled oils are of inferior quality and less value. In addition to the oils discussed in this report mandarin oil and grape-fruit oil sometimes appear in commerce, but are of little or no importance in the American trade.

Lemon oil.—Lemon oil is the most important of the essential citrus oils and is obtained by expression from the fresh peel of the ripe fruit of *citrus medica Limonum Risso* (the ordinary lemon). Lemon oil is a pale yellow or greenish yellow liquid, having the characteristic odor and taste of lemon. According to the United States Pharmacopœia

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(IX), it must have a specific gravity of 0.851 to 0.855 (at 25° C.) and yield not less than 4 per cent of the aldehydes from oil of lemon, calculated as *citral*. In addition to these aldehydes, which are by far the most valuable constituents, lemon oil contains a large proportion of terpenes, which, however, contribute little to either the odor or flavor of the oil. A product from which the terpenes have been separated is known as *"terpeneless" lemon oil* and commands a considerably higher price than does the natural oil.

The largest use for lemon oil is as a flavor for household use and in the preparation of soft drinks and confections. Terpeneless lemon oil is used almost entirely in perfumery, which use also accounts for considerable quantities of the other grades.

Orange oils.—There are two varieties of orange oil in commerce, which are identical in composition and properties, but possess different odors and flavors. *Oil of sweet orange* is obtained from the rinds of *citrus aurantium Risso* and *oil of bitter orange*, from the rinds of *citrus bigaradia Risso*. The former is of much greater importance and is described by the Pharmacopœia as a yellow liquid having the characteristic odor and taste of orange peel. The latter oil, which differs from sweet orange oil mainly in its bitter taste, is not recognized by the United States Pharmacopœia. Orange oil is used in flavoring extracts and confections and to some extent in medicine. Orange oil from which the terpenes have been extracted is used in the manufacture of perfumes.

Bergamot oil.—Oil of bergamot is a yellowish-green liquid obtained by expression from the fresh peel of *citrus aurantium*, subspecies, *Bergamia* (ordinary bergamot). It has a bitter taste but a very pleasant odor and is used in perfumery, in hair oils, and pomades, and for masking odors of ill-smelling substances, such as iodoform and naphthalene.

Oil of limes.—There are three distinct oils in commerce obtained from limes. Italian oil of limes is hand pressed from the peel of *citrus limetta*. Hand-pressed and distilled West Indian oil are derived from *citrus medica* (variety *acida*). The expressed oils are of considerably higher value than the distilled. Oil of limes is used in flavoring extracts and in confections and soft drinks.

Oil of cedrat.—True cedrat oil or oil of citron is obtained by expression from the rind of *citrus medica* (variety *vulgaris*), and is a yellowish liquid very similar to lemon oil. The pure oil is seldom met in commerce and much of the oil known as cedrat oil consists only of a mixture of lemon and orange oils. The oil is of minor importance in this country, although occasionally used in perfumery and flavors.

Oil of neroli.—Oil of neroli or orange flowers is made by distilling the blossoms of bitter and sweet oranges. The bitter orange (*citrus bigaradia*) blossoms yield the more valuable oil, known as oil of neroli, Bigarde, which is the ordinary neroli of commerce. Oil of neroli, Portugal, is that obtained from the sweet orange blossoms. Neroli is a yellowish, slightly fluorescent liquid with an intense and very pleasant odor of orange blossoms. It is one of the most valued perfume oils. Several hundred years ago it was made into a perfume used by the Princess of Neroli, from whom it has received its name.

Other citrus oils.—*Oil of petitgrain* is distilled from the leaves, shoots, and berries of the bitter orange. It is used in perfumes and is somewhat similar to neroli.

Oil of shaddock or grapefruit, as the fruit is called in the United States, is not known to any great extent in commerce. Its constitution and properties are somewhat similar to lemon and orange oils.

Oil of mandarin is obtained from the fruit known as mandarins (*citrus madurensis*). It is a golden yellow liquid with a bluish fluorescence. Its odor and taste are similar to lemon oil. Oil of mandarin is seldom used in the United States.

ADULTERATION AND SUBSTITUTION.

The citrus oils are particularly susceptible of adulteration, and although modern methods of analysis and examination have tended to discourage it, the practice is still common.

Lemon oil was formerly adulterated with turpentine, but this can easily be detected with the polariscope. More skillful sophistication consists in the addition of the terpenes obtained in the manufacture of "terpeneless" oil. This does not affect the specific gravity nor the rotating power, although it does lower the citral content. For this reason it is customary to sell lemon oil with a guaranteed citral content. Bergamot oil is often sold on the basis of its ester content, and by similar "scientific" adulteration this content is fraudulently increased by the addition of artificial esters, such as ethyl citrate.

Orange, lemon, and lime oils may also be adulterated by the addition of the inferior distilled oils. Bergamot and neroli are both produced synthetically and are in considerable demand as substitutes for the natural oils.

FOREIGN AND DOMESTIC PRODUCTION.

By far the largest proportion of the citrus oils are produced in Italy, especially in Sicily and Calabria. The center of this producing region is at Messina, in Sicily, which accounts for the fact that in the trade the citrus oils are often called Messina oils. During 1918 Italy exported 3,500,000 pounds of lemon oil, almost 2,000,000 pounds of bergamot oil, and about 700,000 pounds of orange oil. The United States and the United Kingdom are the principal consumers and account for 90 per cent of the total Italian exports. Calabria supplies practically all of the world's production of bergamot oil; the principal center for this trade is the port of Reggio. Lime oil, however, is mostly of West Indian origin. Dominica and the island of Montserrat are important producing centers. The center of production for oil of neroli is in the Riviera district, in southern France. At Grasse alone about 4,850,000 pounds of orange flowers are annually used in the production of this essence. Imports of neroli from Paraguay have been noted in recent years, but data in regard to the industry in that country are not available.

Orange and lemon oils are the only citrus oils prepared on a commercial scale in the United States. In comparison with the large production in Italy, the domestic output is insignificant. Our production of lemon oil, which is limited to California, was estimated in 1917 at 6,000 pounds, or about 1 per cent of our imports. The domestic production of orange oil during the same year was declared to be negligible.[1]

[1] See War Industries Price Bulletin, No. 50.

METHODS OF PRODUCTION.

The citrus oils are obtained from the peel of the fresh fruit by somewhat similar processes. With the exception of bergamot, all are hand pressed. Some lemon, lime, and orange oil are prepared by distillation processes, but, as previously stated, these products are of inferior quality and of considerably less value. The principal methods for each of the oils will be discussed briefly in the following paragraphs:

Lemon oil.—Lemon oil may be prepared by at least five different processes, viz:

(1) Hand pressed by sponge process.
(2) Hand pressed by écuelle process.
(3) Machine process.
(4) Distillation.
(5) Filter pressing in bags.

The sponge process, which is used almost exclusively in the Sicilian district, furnishes probably 90 per cent of the world's production. The écuelle process receives its name from a simple pan-like apparatus held between the knees of the pressers. It is most largely used for oil of limes, which will be discussed later. The machine process, devised in an attempt to obviate the necessity of hand labor, is not generally used abroad. On account of the high wage scale in the United States, however, machine methods have necessarily replaced hand pressing.

The following description of the sponge process was taken from reports by A. S. Cheney, American consul at Messina, and from J. E. Coit's book on "Citrus fruits."

The fresh fruit is cut in two and the pulp removed from the peel by means of a single knife operated by hand. After the peels have been soaked in water for a few hours they are passed on to the pressers, who sit on low stools holding between their feet a small lipped bowl. "Across the top of the bowl rests a strong notched stick which supports a sponge. Each half lemon (peel) is placed against the sponge and given three or four sharp squeezes, using almost the entire weight of the body. The oil spurting out of the peel is caught by the sponge and drips through it into the bowl. From time to time the bowl is raised and the oil is blown off by the breath into a graduated glass receptacle, the lip retaining the small amount of water and residue. After the oil is filtered through a paper filter it is ready for the market."

The pressers usually work from midnight until noon, since the cooler part of the day is desirable. Each presser handles on the average about 400 pounds of lemon peel per day, from which he extracts about 1½ pounds of lemon oil.

In California the cull lemons are placed in a machine which thoroughly shreds the pulp, which is then filter pressed to produce an emulsion of oil and juice. The emulsion is passed into a centrifugal separator, which separates the oil from the juice, but since the separation is not entirely complete, it is necessary to distill the oil fraction. The distilled oil is not identical with the hand pressed, since the flavor has been changed by the heat. The lemon juice from the centrifuge is used for the manufacture of citrate of lime and citric acid.[1]

[1] See Tariff Information Surveys for Citric Acid and Citrate of Lime.

Oil of limes.—The écuelle used in the production of oil of limes consists of a copper basin 8 to 10 inches in diameter and coated inside with tin. The bottom is covered with sharp spikes one-fourth to one-third inch in length. There is a hole in the bottom of the écuelle, beneath which is a receptacle to catch the oil. The écuelle is held between the knees and the fruit is pressed by hand until the spikes break up the oil cells and liberate the oil. The pulp from the écuelles is pressed in filter presses and the lime juice thus obtained is sold for use as a beverage or used for the production of citrate of lime and citric acid. Women usually are employed and are reported to prepare as much as 2½ pounds of oil per day.

The écuelle process is also used in the West Indies for the manufacture of orange oil, and was formerly used in Calabria for the production of bergamot oil.

Bergamot oil.—The bergamot industry is centered in southern Calabria, where the oil is expressed by a hand-operated machine especially devised for the purpose. The machine is based on the principle of a mortar and pestle, the latter consisting of a number of vertical bars. Pressure is applied and the plunger or pestle is caused to rotate by a wheel and crank operated at the side of the machine. The oil is separated from the water of the crude liquid and filtered through flannel cloths. The machine is adjusted to handle only the globular-shaped fruit and the elongated lemon-shaped fruit are hand pressed, either by the écuelle or sponge processes.

Oil of neroli.—Oil of neroli is produced from the orange blossoms by entirely different methods. In southern France the flowers are gathered during April and May and the petals are separated and covered with water in a steam-heated still. Oil and water are distilled over, and after the oil is separated the water retains enough of the odor and flavor to be valuable for sale as orange flower water.

IMPORTS.

Imports of all essential and distilled oils had increased in value from $2,118,102 in 1910 to $4,905,157 in 1913. The imports declined until 1916, from which time they showed a gradual increase, amounting in 1918 to $3,948,059. Of the total imports of essential oils about 30 per cent are represented by the citrus oils discussed in this report, as may be seen in the following table.

Imports of citrus oils, 1913 and 1918.

Citrus oils.	1913		1918	
	Value.	Total.	Value.	Total.
		Per cent.		*Per cent.*
Lemon	$794,215	16.2	$404,568	10.2
Orange	155,299	3.2	330,506	8.3
Bergamot	310,835	6.3	241,465	6.1
Limes	15,025	.3	73,685	1.9
Neroli	171,932	3.5	84,880	2.1
Cedrat	555	.0	158	.0
Total citrus	1,447,861	29.5	1,135,262	28.6
Total essential and distilled oils	4,906,157	100	3,948,059	100

Lemon oil.—Imports of lemon oil prior to the war showed little variation in quantity, averaging about 400,000 pounds. The considerable variation in value, however, is shown by the fact that in 1910 imports of 415,819 pounds were valued at $310,543, while in 1913, 400,424 pounds were valued at $794,215—an increase of over 100 per cent. Since 1914 there has been a slight increase over prewar imports, notwithstanding the fact that since October, 1913, lemon oil (formerly on the free list) has been dutiable at 10 per cent ad valorem. Imports for the period 1915–1919 averaged 494,613 pounds, valued at $434,734.

The decrease in imports during the fiscal year 1919 was probably caused by the fact that the Italian Government during 1918 requisitioned a large part of the oil of lemon output to be used as a substitute for turpentine, sorely needed in that country, for use in painting battleships and other military equipment. Over 95 per cent of the imports of lemon oil are furnished by Italy.

Orange oil.—Imports of orange oil have been much less than those of lemon oil, but have shown considerably wider variation. Imports in 1912 amounted to 97,065 pounds valued at $168,831, and in 1913 to 79,797 pounds valued at $155,299. There has been a considerable increase since 1914; imports in 1918 were more than double the average prewar imports.

Oil of bergamot.—Maximum imports in recent years were received in 1908 and amounted to 94,967 pounds valued at $284,173. For three years prior to the act of 1913, imports had averaged about 65,000 pounds, but in 1914, simultaneously with the imposition of a duty of 20 per cent, imports decreased to 36,500 pounds. Since that time the imports have shown a tendency to increase and in 1916 surpassed the 1913 figure. The value per unit of quantity has varied from $4.84 in 1913 to $2.56 in 1916. Hand-pressed bergamot oil has come almost entirely from Italy, but before the war Germany furnished us with considerable quantities of artificial bergamot oil and also with certain highly refined grades.

Oil of limes.—Imports of oil of limes have shown variation both in quantity and value. In 1908 the imports amounted to 6,765 pounds valued at about 75 cents a pound, and in 1918 they reached 29,137 pounds valued at over $2.50 per pound. The imposition of a duty on oil of limes in 1913 had no noticeable effect upon the imports.

Neroli or orange flower oil.—Maximum prewar imports of neroli were received in 1913 and amounted to 38,365 pounds valued at $171,932. During 1914 and 1915 there was a decrease of about 30 per cent in the imports but in 1916 and again in 1918, imports were in excess of 30,000 pounds. The value per unit of quantity has varied from $10.50 per pound in 1908 to $1.93 in 1916.

Cedrat oil.—Only a very small quantity of cedrat oil is imported into the United States. The maximum imports in 1915 were 788 pounds valued at $3,721. The large variation in value is probably due to the fact that various fictitious oils are offered under the name of *cedrat*, and that the genuine oil from *citrus medica* is rarely met with in commerce.

PRICES.

As Meldrum [1] has pointed out, the history of the price fluctuations for essential oils has shown a rhythmic rise in prices with strengthening demand followed by overproduction and consequent price depression. It should be noted, however, that the influences of speculation often have a marked effect on the essential oil market. It is not uncommon for prices to be suddenly forced up and artificially maintained apparently without any sound commercial or economic reason. Prices for the individual oils, shown in the tables on pages 28–31, are discussed in the following paragraphs:

Lemon oil.—During 1913 the price of lemon oil was unusually high and in August, 1913, it reached $4.75 per pound. The latter months of 1913 saw the beginning of a gradual decline and during the first quarter of 1914 the price had dropped as low as $2.45. Prices continued to fall and the average for the entire year of 1915 was $1.075 per pound.

The lowest price in recent years was reached during August and September of 1916, when the oil was quoted at 90 cents per pound. There were occasional fluctuations during 1917, 1918, and 1919, but this is not shown by the yearly averages, which were as follows: 1917, $1.125; 1918, $1.158; and 1919, $1.275.

Orange oil.—During the period 1913 to 1915 orange-oil prices followed the same general decline as did those for lemon oil. The yearly averages were as follows: 1913, $3.3135; 1914, $2.475; and 1915, $1.70. In May, 1916, the price had increased to $2.85, and in October to $3. This high level was maintained during 1917 and for most of 1918. Toward the end of 1919 a further increase brought the price up to $3.25 per pound.

Oil of bergamot.—The average prices for bergamot oil during the last seven years have been as follows: 1913, $6.0667 per pound; 1914, $5.45 per pound; 1915, $3.2125 per pound; 1916, $4.20 per pound; 1917, $5.9792 per pound; 1918, $6.0708 per pound; 1919, $5.7375 per pound.

From $6.50 per pound in January, 1913, the price dropped to $3 in April, 1915, but since that time there has been a gradual increase which reached a maximum of $7.50 in October and November, 1918. Synthetic oil of bergamot, although of somewhat lower price, has followed the same general trend as the natural product.

Oil of limes.—Price quotations for oil of limes are shown only occasionally in the Oil, Paint, and Drug Reporter. The price of the expressed oil varied between $3 and $4 per pound during 1914, 1915, 1916, and 1917. In January, 1918, expressed oil of limes was quoted at $5.75 to $6, and in January, 1919, at $4.90 to $5. Distilled oil of limes was quoted at 75 cents in August, 1914, but by the beginning of 1916 the price had advanced to $2.50, and this level, with only a little variation, has been maintained since that time.

Oil of neroli.—Several varieties of this very valuable essential oil are shown in the price quotations. For a year and a half prior to the war, *oil of neroli, petale*, was quoted at $45 per pound. In July, 1914, fear of a short crop caused a rise to $51 and further

[1] Meldrum, W. B.: Prices of Essential Oils, Flavoring and Perfume Materials, War Industries Board Price Bulletin, No. 50, Washington (1919).

increase to $60 followed in October. During 1915, however, there was a return to the prewar level, which was maintained during 1916, and the first half of 1917. Short crops and labor difficulties at that time caused an increase to $85 in October, 1917, and to $90 during November and December of 1918. Supplies continued to be short during 1919, and by the end of the year oil of neroli petale had reached $130 per pound. *Oil of neroli bigarde* generally commands a slightly lower price and in January, 1920, it was quoted at $120. A synthetic neroli has been quoted since 1918 and has varied in price from $15 to $30 per pound.

TARIFF HISTORY.

The essential citrus oils of bergamot, cedrat, lemon, limes, and neroli or orange flowers, were mentioned specifically in the free list of the tariff acts of 1883, 1890, 1894, and 1897. The act of 1909 made specific provision in the free list for all of the above oils with the exception of *orange oil*. Imports of this article were classified under paragraph 21 ("fruit ethers, oils, or essences") at $1 per pound during 1910 and 1911. In June, 1911 (T. D. 31718, G. A. 7239) it was held to be dutiable at 25 per cent ad valorem as an essential oil n. s. p. f. In the act of 1913 orange and lemon oils became dutiable at 10 per cent ad valorem, and a rate of 20 per cent ad valorem was provided for the oils of bergamot, cedrat, limes, and neroli or orange flower.

TARIFF CONSIDERATIONS.

The imported citrus oils for the most part do not compete with domestic products. Lemon and orange oils are produced in this country, but as yet the industries are able to supply only a relatively small proportion of the consumption. Since lemon and orange oils are by-products of the citrus industry, it may be urged that their complete recovery will utilize inferior grades of fruit which at present are wasted. In this way their recovery would strengthen the citrus industry without increasing the prices for its principal products. On the other hand, these articles require a large amount of hand labor and for that reason they can not be prepared under the same methods as cheaply in this country as abroad. The application of machine methods has been tried and has undoubtedly lowered the cost of production, but the products thus obtained are not identical with the hand-pressed oils and are of less value. Superior methods of cultivation used in this country have resulted in a smaller proportion of "culls" or inferior fruit than is obtained abroad—and it is therefore doubtful whether a domestic by-products industry can ever be developed sufficiently to supply the entire American demand.

The imposition of a duty on the citrus oils in 1913 has had little if any effect upon the volume of the imports, and has resulted in an annual revenue of about $135,000. These oils are used in the manufacture of perfumes, and flavors for soft drinks, and confections, and in this connection may be regarded in the class of luxuries. However, in establishing the rates of duty on these oils, consideration should logically be given to the rates imposed upon the finished products—perfumes and flavors.

Oil of orange, oil of bergamot, oil of lemon—Exports of citrus oils from Italy, 1912–1919.

Year.	Oil of bergamot.		Oil of lemon.		Oil of orange.		Oil of mandarins.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1912	157,283	$853,690	1,141,092	$1,498,440	118,615	$218,064	2,088	$10,052
1913	139,095	803,679	1,007,293	3,086,393	106,048	278,516	2,013	10,573
1914	136,149	476,764	1,329,369	2,094,815	94,441	157,087	2,163	7,195
1915	232,702	651,895	1,640,247	1,794,928	155,803	218,235	2,661	10,716
1916	346,486	1,304,312	1,445,164	1,201,899	211,767	500,553	4,054	25,199
1917	294,973	1,678,508	1,151,873	1,109,238	159,496	488,704	5,401	33,099
1918	301,737	1,981,150	1,283,897	1,798,365	108,266	379,121	4,766	33,382
1919	[1] 428,839	2,815,677	[1] 1,670,511	2,339,898	[1] 229,087	802,208	[1] 8,909	62,393

[1] Preliminary figure from monthly report for December, 1919.

Exports of Italian essential citrus oils, by principal countries, 1916.

Countries.	Oil of orange.		Oil of lemon.		Oil of bergamot.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	33,065	$78,155	86,356	$71,819	10,246	$385,688
Great Britain	34,226	80,901	355,293	295,487	6,932	260,921
Russia	12,419	29,354	44,921	37,259	2,867	107,945
Switzerland	41,799	98,801	123,916	103,057	3,770	141,921
Australia	2,767	6,540	51,182	42,567	154	5,950
United States	66,877	158,076	637,132	29,883	4,872	183,416
All other	20,611	48,728	14,636	121,726	5,808	218,471
Total	211,767	500,553	144,516	1,201,899	34,649	1,304,512

Source: Movimento Commerciale del Regno D'Italia, 1916, Rome.

IMPORTS INTO THE UNITED STATES.

Lemon oil—Imports by countries (fiscal years).

Imported from—	1909 [1]		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	.....	.....	1,784	$5,750	1,334	$8,857
Italy	.....	.....	412,630	302,019	426,117	310,054
United Kingdom	.....	.....	.....	.....	1,000	1,156
All other	.....	.....	1,087	1,614	2,007	2,660
Total	.....	.....	415,501	309,383	430,458	322,727

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	1,943	$13,875	9,819	$28,639	13,458	$28,937
Italy	346,083	425,128	363,172	698,227	362,839	806,002
United Kingdom	1,015	1,454	3,824	9,816	7,156	18,879
All other	8,133	11,131	4,278	7,976	2,506	4,402
Total	357,174	451,588	381,093	744,658	385,959	858,220

[1] Included in "All other volatile oils" prior to 1910.

Lemon oil—Imports by countries (fiscal years)—Continued.

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	707	$7,232	40	$56	.....	.....
Italy	575,657	589,462	543,125	440,400	443,334	$365,738
United Kingdom	646	2,608	.....	.....	1,000	1,000
All other	585	1,340	692	1,454	5,401	7,195
Total	577,595	600,642	543,857	441,910	449,735	373,933

Imported from—	1918	
	Pounds.	Value.
Italy	588,465	$381,492
United Kingdom	4,903	6,066
All other	34,689	39,760
Total	628,057	427,318

Lemon oil—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	440,326	$592,533	.....	$1.34	.....
1909	.....do	405,695	358,197	.....	.88	.....
1910	.....do	415,819	310,543	.....	.74	.....
1911	.....do	430,768	323,552	.....	.75	.....
1912	.....do	400,424	491,690	.....	1.23	.....
1913	.....do	410,003	794,215	.....	1.94	.....
1914	.....do	62,835	187,085	.....	3.00	.....
1914	10 per cent	263,485	557,699	$55,769	2.12	10.00
1915	.....do	557,347	621,592	62,159	1.12	10.00
1916	.....do	435,030	360,862	36,086	.83	10.00
1917	.....do	557,288	459,179	45,917	.82	10.00
1918	.....do	577,600	404,568	40,456	.70	10.00
1919	.....do	345,799	327,470	32,747	.95	10.00

Orange oil—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	71,224	$165,982	.....	$2.33	.....
1909	.....do	87,591	151,860	.....	1.73	.....
1910	.....do	13,336	19,798	.....	1.48	.....
1910	$1 per pound	33,465	45,307	$33,465	1.36	73.87
1911	.....do	73,786	99,303	73,786	1.35	74.30
1912	25 per cent [1]	97,065	168,831	42,207	1.74	25.00
1913	.....do	79,797	155,299	38,824	1.95	25.00
1914	.....do	11,537	25,059	6,264	2.17	25.00
1914	10 per cent	92,954	197,059	19,705	2.12	10.00
1915	.....do	97,014	140,246	14,024	1.44	10.00
1916	.....do	97,359	134,025	13,402	1.37	10.00
1917	.....do	170,722	322,373	32,237	1.88	10.00
1918	.....do	196,846	330,506	33,050	1.68	10.00
1919	.....do	126,532	246,202	24,620	1.94	10.00

[1] Treasury decision 31718 (G. A. 7239).

Bergamot oil—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	94,967	$284,173		$2.99	
1909	do	89,957	281,211		3.13	
1910	do	38,155	133,490		3.49	
1911	do	65,199	222,225		3.41	
1912	do	67,526	315,227		4.67	
1913	do	64,259	310,835		4.84	
1914	do	11,494	33,301		2.90	
1914	20 per cent	25,153	105,329	$21,065	4.19	20.00
1915	do	56,781	150,062	30,012	2.95	20.00
1916	do	69,440	178,300	35,660	2.56	20.00
1917	do	50,634	179,182	35,836	3.55	20.00
1918	do	57,689	241,465	48,293	4.18	20.00
1919	do	41,262	185,318	37,064	4.50	20.00

Oil of limes—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	6,765	$4,976		$0.74	
1909	do	21,991	9,973		.45	
1910	do	8,025	9,137		1.14	
1911	do	9,122	9,466		1.04	
1912	do	12,821	9,165		.71	
1913	do	13,075	15,025		1.15	
1914	do	4,725	7,643		1.62	
1914	20 per cent	11,834	16,185	$3,237	1.37	20.00
1915	do	9,154	9,279	1,855	1.01	20.00
1916	do	19,765	29,694	5,938	1.50	20.00
1917	do	26,551	49,001	9,800	1.84	20.00
1918	do	29,137	73,685	14,737	2.52	20.00
1919	do	16,272	24,273	4,847	1.49	20.00

Neroli or orange-flower oil—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	11,271	$118,301		$10.50	
1909	do	23,184	170,342		7.35	
1910	do	26,053	70,433		2.70	
1911	do	16,207	49,306		3.04	
1912	do	17,437	71,054		4.07	
1913	do	38,365	171,932		4.48	
1914	do	13,663	62,579		4.58	
1914	20 per cent	2,265	10,686	$2,137	4.70	20.00
1915	do	13,251	31,478	6,295	2.37	20.00
1916	do	34,447	66,768	13,353	1.93	20.00
1917	do	23,639	66,394	13,278	2.80	20.00
1918	do	32,687	84,880	16,976	2.59	20.00
1919	do	10,595	52,850	10,570	4.98	20.00

Cedrat-oil—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	47	$263		$5.60	
1909	do	297	950		3.20	
1910	do	210	612		2.91	
1911	do	129	955		7.40	
1912	do	424	1,329		3.13	
1913	do	115	555		4.83	
1914	do	86	415		4.83	
1914	20 per cent	73	355	$71	4.86	20.00
1915	do	788	3,721	744	4.72	20.00
1916	do	438	1,966	393	4.48	20.00
1918	do	200	158	31	.79	20.00
1919	do	336	531	106	1.57	20.00

Oil of bergamot—Prices per pound.

[From War Industries Board Bulletin No. 50 and Oil, Paint, and Drug Reporter.]

Quarters, 1913: [1]	
First	$6.43
Second	6.00
Third	5.70
Fourth	6.13
Quarters, 1914: [1]	
First	6.03
Second	5.48
Third	5.53
Fourth	4.75
Quarters, 1915: [1]	
First	3.38
Second	3.08
Third	3.13
Fourth	3.25
Quarters, 1916: [1]	
First	3.41
Second	3.61
Third	4.35
Fourth	5.41
Quarters, 1917: [1]	
First	$6.00
Second	5.91
Third	6.00
Fourth	6.00
Quarters, 1918: [1]	
First	5.66
Second	5.50
Third	5.78
Fourth	7.33
Quarters, 1919: [2]	
First	6.90
Second	6.40
Third	5.15
Fourth	4.50
Quarters, 1920: [2]	
First	5.00
Second	7.50
Third	6.75
Fourth	6.25

[1] Quarterly prices, or average of monthly prices from Oil, Paint, and Drug Reporter.
[2] Low, first Monday in each month, from Oil, Paint, and Drug Reporter.

Oil of lemon—Prices, dollars per pound.

[From War Industries Board Bulletin No. 50 and Oil, Paint, and Drug Reporter.]

Quarters, 1913: [1]	
First	$2.70
Second	3.33
Third	4.46
Fourth	3.55
Quarters, 1914: [1]	
First	2.73
Second	2.15
Third	2.16
Fourth	1.53
Quarters, 1915: [1]	
First	1.11
Second	1.05
Third	1.11
Fourth	1.01
Quarters, 1916: [1]	
First	1.00
Second	.95
Third	.91
Fourth	1.01
Quarters, 1917: [1]	
First	$1.18
Second	1.13
Third	1.11
Fourth	1.06
Quarters, 1918: [1]	
First	.98
Second	1.13
Third	1.08
Fourth	1.43
Quarters, 1919: [2]	
First	1.60
Second	1.26
Third	1.15
Fourth	1.15
Quarters, 1920: [2]	
First	—1.45
Second	2.00
Third	—1.65
Fourth	1.15

[1] Quarterly prices, or average of monthly prices from Oil, Paint, and Drug Reporter.
[2] Low, first Monday in each month, from Oil, Paint, and Drug Reporter.

Oil of orange, sweet Italian, prices per pound.

[From War Industries Board Bulletin No. 50 and Oil, Paint, and Drug Reporter.]

Quarters, 1913:[1]	
First	$2.85
Second	3.11
Third	3.71
Fourth	3.56
Quarters, 1914:[1]	
First	2.95
Second	2.45
Third	2.61
Fourth	1.88
Quarters, 1915:[1]	
First	1.56
Second	1.61
Third	1.85
Fourth	1.76
Quarters, 1916:[1]	
First	1.86
Second	2.53
Third	2.83
Fourth	2.86
Quarters, 1917:[1]	
First	$3.00
Second	2.86
Third	3.03
Fourth	2.80
Quarters, 1918:[1]	
First	2.55
Second	2.56
Third	2.58
Fourth	3.00
Quarters, 1919:[2]	
First	2.90
Second	3.10
Third	2.90
Fourth	3.25
Quarters, 1920:[2]	
First	5.25
Second	9.00
Third	10.75
Fourth	6.25

[1] Quarterly prices or average monthly prices from Oil, Paint, and Drug Reporter.
[2] Low, first Monday in each month, from Oil, Paint, and Drug Reporter.

Orange, bitter, prices, per pound.

[From Oil, Paint, and Drug Reporter.]

April, 1915	$1.75-$2.00
July, 1915	2.00- 2.10
October, 1915	2.00- 2.10
January, 1916	2.00- 2.10
April, 1916	1.95- 2.00
July, 1916	2.25- 2.75
October, 1916	2.25- 2.75
January, 1917	2.50- 3.25
April, 1917	2.35- 2.85
July, 1917	2.40- 3.40
October, 1917	2.40- 2.60
January, 1918	2.15- 2.25
April, 1918	$1.75-$1.80
July, 1918	1.75- 1.80
October, 1918	1.75- 1.80
January, 1919	1.75- 2.00
April, 1919	1.75- 2.00
July, 1919	2.00- 2.25
October, 1919	2.25- 2.35
January, 1920	3.75- 4.00
April, 1920	7.00- 7.50
July, 1920	7.75- 8.00
October, 1920	5.75- 6.00

Orange, West Indian—Prices, per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$2.05-$2.10
January, 1915	1.50- 1.60
April, 1915	1.25- 1.35
July, 1915	1.50- 1.60
October, 1915	1.70- 1.75
January, 1916	1.50- 1.60
April, 1916	1.75- 1.80
July, 1916	2.50- 2.75
October, 1916	2.75- 2.80
January, 1917	2.25- 2.35
April, 1917	2.35- 2.45
July, 1917	2.67- 2.75
October, 1917	2.30- 2.45
January, 1918	$2.00-$2.10
April, 1918	1.80- 1.90
July, 1918	1.80- 1.90
October, 1918	1.75- 1.80
January, 1919	1.75- 1.80
April, 1919	1.75- 1.80
July, 1919	1.90- 2.00
October, 1919	2.35- 2.40
January, 1920	4.00- 4.25
April, 1920	7.50- 7.75
July, 1920	9.00- 9.25
October, 1920	6.00- 6.25

Bergamot—Prices, per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$5.00-$5.25
January, 1915	3.75
April, 1915	3.00- 3.15
July, 1915	3.15- 3.50
October, 1915	3.15- 3.50
January, 1916	3.50
April, 1916	3.30- 3.50
July, 1916	3.70- 3.75
October, 1916	5.50- 5.75
January, 1917	6.25- 6.50
April, 1917	5.75- 6.00
July, 1917	6.00- 6.25
October, 1917	6.00- 6.20
January, 1918	$6.00-$6.20
April, 1918	5.50- 6.00
July, 1918	5.60- 5.75
October, 1918	7.50- 8.00
January, 1919	7.00- 7.50
April, 1919	6.40- 6.50
July, 1919	5.15- 5.50
October, 1919	4.75- 5.00
January, 1920	5.00- 5.25
April, 1920	7.50- 7.75
July, 1920	6.75- 7.00
October, 1920	6.25- 6.50

Bergamot, synthetic—Prices, per pound.

[From Oil, Paint, and Drug Reporter.]

July, 1915	$2.50–$2.75	April, 1918	$3.50–$4.00
October, 1915	2.50– 2.75	July, 1918	3.75– 3.89
January, 1916	2.50– 2.75	October, 1918	4.00– 4.25
April, 1916	2.90– 3.00	January, 1919	4.00– 4.25
July, 1916	2.90– 3.00	April, 1919	4.00– 4.25
October, 1916	2.90– 3.00	July, 1919	4.00– 4.25
January, 1917	2.75– 3.00	October, 1919	4.00– 4.25
April, 1917	2.75– 3.00	January, 1920	4.00– 4.25
July, 1917	3.00– 3.20	April, 1920	4.00– 4.25
October, 1917	3.00– 3.50	July, 1920	4.00– 4.25
January, 1918	3.50– 4.00	October, 1920	4.00– 4.25

Oil of lime, expressed, prices, per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$3.25–$3.50	January, 1918	$5.75–$6.00
January, 1915	3.00– 3.10	April, 1918	5.50– 5.75
April, 1915	2.65– 2.75	July, 1918	5.25– 5.50
July, 1915	2.75– 2.85	October, 1918	5.00– 5.25
October, 1915	2.75– 3.00	January, 1919	4.90– 5.00
January, 1916	2.75– 3.00	April, 1919	4.50– 4.75
April, 1916	2.75– 3.00	July, 1919	3.95– 4.00
July, 1916	3.15– 3.25	October, 1919	3.75– 3.85
October, 1916	3.15– 3.25	January, 1920	3.50– 3.75
January, 1917	3.50– 4.00	April, 1920	5.50– 5.75
April, 1917	5.00– 5.25	July, 1920	(1)
July, 1917	5.50– 6.00	October, 1920	5.50– 5.60
October, 1917	6.50		

Oil of lime, distilled, prices, per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$0.75–$0.80	January, 1918	$2.25–$2.35
January, 1915	1.35– 1.40	April, 1918	2.00– 2.25
April, 1915	1.10– 1.15	July, 1918	1.90– 2.00
July, 1915	1.60	October, 1918	1.85– 1.90
October, 1915	2.35	January, 1919	1.65– 1.75
January, 1916	2.25– 2.35	April, 1919	1.50– 1.60
April, 1916	2.25– 2.50	July, 1919	1.15– 1.25
July, 1916	2.75– 3.00	October, 1919	1.10– 1.15
October, 1916	2.75– 3.00	January, 1920	1.00– 1.10
January, 1917	2.75– 3.00	April, 1920	1.00– 1.25
April, 1917	2.50– 2.75	July, 1920	2.25– 2.40
July, 1917	2.75– 2.85	October, 1920	1.75– 1.85
October, 1917	2.75– 2.85		

Neroli-bigarade, prices, per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$40.00–$50.00	January, 1918	$70.00–$80.00
January, 1915	55.00	April, 1918	70.00– 80.00
April, 1915	35.00– 40.00	July, 1918	70.00– 80.00
July, 1915	35.00– 40.00	October, 1918	80.00–100.00
October, 1915	35.00– 50.00	January, 1919	80.00–120.00
January, 1916	35.00– 50.00	April, 1919	130.00
April, 1916	35.00– 50.00	July, 1919	120.00
July, 1916	35.00– 50.00	October, 1919	120.00
October, 1916	35.00– 50.00	January, 1920	120.00
January, 1917	35.00– 50.00	April, 1920	120.00
April, 1917	35.00– 50.00	July, 1920	120.00
July, 1917	40.00– 50.00	October, 1920	(1)
October, 1917	75.00– 78.00		

[1] Nominal.

Neroli-synthetic and oil of neroli, petale—Prices, dollars per pound.

[From Oil, Paint, and Drug Reporter and War Industries Board Bulletin No. 50.]

Neroli, synthetic:	
April, 1916	$18.00–$20.00
July, 1916	18.00– 20.00
October, 1916	18.00– 20.00
January, 1917	18.00– 20.00
April, 1917	18.00– 20.00
July, 1917	18.00– 20.00
October, 1917	18.00– 24.00
January, 1918	18.00– 24.00
April, 1918	18.50– 25.00
July, 1918	18.50– 24.00
October, 1918	18.50– 24.00
January, 1919	20.00– 30.00
April, 1919	18.50
July, 1919	18.50
October, 1919	14.00– 15.00
January, 1920	14.00– 15.00
April, 1920	14.00– 15.00
July, 1920	14.00– 15.00
October, 1920	14.00– 16.00
Oil of neroli, petale:	
January, 1913	$45.00
April, 1913	45.00
July, 1913	45.00
October, 1913	45.00
January, 1914	45.00
Oil of neroli, petale—Continued:	
April, 1914	$45.00
July, 1914	51.00
October, 1914	60.00
January, 1915	53.33
April, 1915	50.00
July, 1915	46.66
October, 1915	45.00
January, 1916	45.00
April, 1916	45.00
July, 1916	45.00
October, 1916	45.00
January, 1917	45.00
April, 1917	50.00
July, 1917	63.33
October, 1917	83.33
January, 1918	80.00
April, 1918	80.00
July, 1918	80.00
October, 1918	90.00
April, 1919	120.00
July, 1919	130.00
October, 1919	130.00
January, 1920	130.00
April, 1920	130.00
July, 1920	130.00
October, 1920	(1)

[1] Nominal.

Bergamot, cedrat, orange, lemon, lime, and neroli or orange flower oils, rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
		Oils:	
1883	561	Bergamot	Free.
1883	574	Lemon	Do.
1883	575	Limes	Do.
1883	577	Neroli or orange flower	Do.
1883	578	Orange	Do.
1883	565	Cedrat	Do.
1890	661	Oils: * * * bergamot, * * * cedrat * * * lemon, limes, * * * neroli or orange flower, * * * orange oil, * * * .	Do.
1894	568	Oils: * * * bergamot, * * * cedrat, * * * lemon, limes, * * * neroli or orange flower * * * orange oil, * * * .	Do.
1897	626	Oils: * * * bergamot, * * * cedrat, * * * lemon, limes, * * * neroli or orange flower, * * * orange oil * * * .	Do.
1909	639	Oils: * * * bergamot, * * * cedrat, * * * lemon, limes, * * * neroli or orange flower, * * * .	Do.
1909	3	* * * distilled oils, essential oils, * * * and all combinations of the foregoing, * * * not specially provided for in this section.	55 cents per pound, but not less than 25 per cent.
1909	21	* * * fruit ethers, oils, or essences, *Provided*, That no article of this paragraph shall pay a less rate of duty than 25 per centum ad valorem.	$1 per pound.
1913	46	Oils, distilled and essential: Orange and lemon * * * bergamot * * * cedrat * * * limes; neroli or orange flower * * * *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.	10 per cent. 20 per cent.

Court and Treasury Decisions.

Oils have been in issue under several tariff acts. Citral, a highly concentrated and refined form of oil of lemon, from which nearly all terpin constituents had been extracted, was classified as oil of lemon under the act of 1890. (In re Fritzsche, 56 Fed., 819, affirming G. A. 999 (T. D. 12137).)

But so-called concrete essence of lemon, containing 21.43 per cent of lemon oil, was held dutiable as an unenumerated manufactured article rather than as lemon oil under the act of 1909. (In re Ritchie, Abstract 35786 (T. D. 34521).)

[1] Nominal.

Oil of lemon, put up in bottles containing less than 2½ pounds gross weight became the subject of litigation because of the provision in paragraph 17 of the act of 1913, making dutiable thereunder chemical and medicinal compounds or combinations, and all similar articles dutiable under section 1 of that act, except soap, whether specially provided for or not, put up in individual packages of 2½ pounds or less gross weight. The Treasury Department at first construed this provision to embrace all articles provided for in schedule A, whether eo nomine or otherwise, except soap and sponges. (Department Order, T. D. 34035.) But upon further investigation the department reached the conclusion that oil of lemon, among other oils, did not fall within paragraph 17, not being similar to chemical and medicinal compounds or combinations. (T. D. 34184.)

The court of Customs Appeals concurred in this construction in a case arising upon sweet almond oil and castor oil. (Monticelli Bros. *v.* United States, 8 Ct. Cust. Appls., 21–7, T. D. 37162.) The phrase "medicinal compounds, combinations, and all similar articles" was interpreted to mean (1) strictly medical compounds and combinations, and (2) compounds or combinations similar thereto in that, although not strictly medical, because possessing properties adapting them to other uses, are nevertheless susceptible of medicinal uses, and in the form and condition imported are specially designed therefor and chiefly so used.

Orange oil, made from the natural fruit and known in trade as "essential oil" rather than as "fruit oil," was held dutiable under paragraph 3 of the act of 1909 as an essential oil and not under paragraph 46 as a fruit oil. (G.-A. 7239, T. D. 31718, of 1911.)

CITRONELLA AND LEMON-GRASS OILS.

SUMMARY.

TARIFF ACT OF 1913.

> Paragraph 46,' 'oils, distilled and essential: * * * citronella and lemon-grass; * * * 20 per centum ad valorem: *Provided*, That no article containing alcohol shall be classfied for duty under this paragraph."

Citronella and lemon-grass oils are closely related essential oils distilled from grasses grown in India, Ceylon, and Java. They are used in the manufacture of cheap perfumery, especially in scented toilet soaps. From them are also obtained certain odoriferous constituents which on further manufacture yield important synthetic perfume materials.

Neither of the oils is produced in the United States although the Department of Agriculture has demonstrated that lemon-grass can be cultivated successfully in subtropical districts such as are found in Florida and other parts of this country. Lemon-grass grows wild in the Philippines, but apparently no effort has been made to produce the oil on a commercial scale from either wild or cultivated grasses.

Imports of citronella and lemon-grass oils (grouped in the official statistics) have averaged slightly less than a million pounds, valued at about $300,000. Over three-fourths of the total imports are probably of citronella oil, most of which is obtained from Ceylon. Javan citronella oil is of better quality, is less often adulterated, and

accordingly, commands a higher price. The annual imports of lemon-grass oil have been estimated at about 100,000 pounds, valued at least at $100,000.

Citronella and lemon-grass oils were mentioned specifically on the free lists of the tariff acts of 1883, 1890, 1894, 1897, and 1909. They became dutiable under the act of 1913 at 20 per cent ad valorem. The imposition of this duty has not affected the volume of the imports and has yielded an average annual revenue of approximately $65,000.

General Information.

DESCRIPTION AND USES.

Citronella oil.—Citronella oil is distilled from Indian or citronella grass, which is known botanically as *Andropogon nardus*. There are two principal varieties of this grass, the most important of which is the *Lana batu*, grown in Ceylon and India. In Java citronella oil is distilled from "winter grass," which is the *Maha pangiri* variety. Citronella oil is a pale yellow or brownish oil possessing a powerful but pleasant odor. The latter property, along with its low price, accounts for its use in cheap perfumery, especially in soap manufacture. Javan oil is of considerably higher value than the Ceylon oil, and has a different and much finer odor. The inferior quality of the Ceylon oil is due to some extent at least to the consistent practice of adulteration. Prior to the last few years, pure Ceylon citronella oil was seldom sold. The principal adulterants are petroleum, fatty oils, and benzine or motor spirits.

Efforts made to force the producers in Ceylon to eliminate adulteration with petroleum resulted in the use of a solubility test known as the Schimmel test, which is based on the fact that the pure oil is soluble in 10 volumes of 80 per cent alcohol. It has recently been claimed that this test is not a satisfactory index of all forms of adulteration and in its stead there has been proposed a test based on the ester content. Most of the commercial oil from Ceylon contains about 55 per cent of the total *geraniol* esters (that is, *geraniol* plus *citronellol*).

Lemon-grass oil.—Lemon-grass oil, which is closely related to citronella oil, is obtained by the distillation of certain varieties of the grass *Cymbopogon citratus*. Lemon-grass oil is also known as oil of verbena, East Indian or Indian Melissa. Ceylon and Singapore are centers for the cultivation of the grass and the production and exportation of the oil. Large production is also reported in Burma, and in southern India (Travancore district).

Lemon-grass oil, like citronella, is used chiefly in cheap perfumery and toilet soaps. It is the commercial source of the aldehyde, *citral*, which is used in the manufacture of synthetic violet perfumery of the ionone type. The alcohol, *geraniol*, the principal constituent of rose oil, is also commercially obtained from lemon-grass oil. These two uses probably account for the largest proportion of the domestic consumption. In India lemon-grass oil is used both internally and externally to ward off disease and as a protection against insects.

Lemon-grass oil normally contains 68 to 85 per cent of citral, and for this reason it is occasionally added to adulterate lemon oil in order to increase its citral content.

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PRODUCTION AND TRADE.

Neither citronella nor lemon-grass oil is produced in the United States. In 1917 the Department of Agriculture investigated the possible domestic production of lemon grass oil,[1] and concluded that there is no reason why the lemon grass (*Cymbopogon citratus*) can not be successfully cultivated in the subtropical districts of the United States, especially in the high pine lands of Florida. Some experimental cultivation was carried on in 1917, but the work has now been discontinued.

Citronella oil.—The most important center of production for citronella oil is in Ceylon, where over 50,000 acres are devoted to the cultivation of the *Lana batu* variety of grass. Growth is continuous, and three harvests are usually obtained each year. The annual yield of oil ranges between 30 and 40 pounds per acre. The stills usually consist of steam boilers, 6 to 8 feet high and 3 to 4 feet broad, equipped with a spiral condenser inclosed in a vessel filled with cold water. A still will produce from 20 to 30 pounds of oil per day.

The exports of citronella oil from Ceylon have been as follows:

Year.	Total export.	To United States.
	Pounds.	*Pounds.*
1910	1,762,916	.....
1911	1,574,965	.....
1912	1,420,306	493,333
1913	1,602,481	504,705
1914	1,425,943	529,443
1915	1,633,895	899,001
1916	1,366,014	620,774
1917	1,197,507	785,032

The Ceylon exports of citronella oil by countries for the years 1914 and 1915 are shown in the table on page 36.

The Javan production of citronella oil is on a somewhat smaller scale, although in recent years it has increased considerably. The product is of considerably higher value than Ceylon oil, principally because of its high ester content.

The exports during recent years from Java have been as follows:[2]

	Pounds.		Pounds.
1912	169,459	1916	428,743
1913	166,070	1917	515,573
1914	136,654	1919	528,534
1915	233,326		

The exports by countries for 1912 and 1913 are shown on page 37.

The production of citronella oil in Burma began in 1912. The Burmese oil appeared on the London market in 1914 and was declared to be equal to the Javan product. According to a report by the United States consul at Madras the method of production is as follows:

The distillation is carried on in a copper pot still of 100 gallons capacity, into which is fitted a perforated basket holding the chopped

[1] Hood, S. C., "Possible production of lemon-grass oil," U. S. Dept. of Agriculture Bulletin 442 (1917).
[2] See Drug and Chemical Markets, p. 27, July 7, 1920.

grass. The still is filled two-thirds full of water and is heated by a furnace, using wood for fuel. Oil and water are distilled over and the former, being lighter, floats on top and is easily separated. After settling, the clear oil is ready for the market. It is sometimes filtered, but this process is not necessary for most commercial purposes.

Lemon-grass oil.—The lemon-grass oil of commerce is almost entirely of East Indian or Indian origin. Production is carried on in the Province of Travancore, south of Cochin. Trivandrum is an important commercial center for this trade. Some oil is also distilled in Ceylon, but in comparison with the citronella oil output the production is on a very small scale. Lemon-grass oil was formerly distilled on a fairly large scale in the Straits Settlements, but in recent years there has been a considerable decline in the industry. Singapore was the center of this trade. The exports of lemon-grass oil from Cochin for 1911 and 1912 were as follows:

Year.	Total export.	To United States.
	Pounds.	*Pounds.*
1911	144,523	13,645
1912	248,886	23,826

Lemon grass is not cultivated in the Philippines, but experiments have shown that three crops can be harvested annually from the wild grass. The related oil known as ogarugawa is produced from a related variety of grass grown in Japan.

IMPORTS.

Imports of citronella oil and lemon-grass oil have been grouped together in the official statistics of Commerce and Navigation. Imports have shown considerable variation since 1908, ranging from 1,104,967 pounds in 1912 to 549,837 pounds in 1919. The average imports for the period 1908–1919 were 884,378 pounds, valued at $289,761. During the fiscal year 1914, according to the Department of Commerce (miscellaneous series No. 82), there was received 598,063 pounds of Ceylon citronella oil valued at $0.386 per pound, and 67,892 pounds of Javan citronella oil valued at $0.69 per pound. Imports of lemon-grass oil are probably in the neighborhood of 100,000 pounds per year.

Imports for consumption are shown in the table on page 37.

PRICES.

Citronella oil.—Ceylon citronella oil is ordinarily priced much lower than the oil from Java. The Ceylon variety showed little variation in price prior to the beginning of 1920, averaging about 50 cents per pound. In January, 1920, the price was increased to 65 cents, further increased to 75 cents in April, and at the beginning of the third quarter of 1920 was quoted at 88 to 90 cents per pound.

Javan citronella oil during 1914 and 1915 sold at about $1.25 per pound. The price fell to 90 to 95 cents during 1916 and to 80 to 85 cents in 1917. Prices continued to fall during the next two years,

reaching the low figure of 65 to 70 cents in January, 1919. As in the case of Ceylon oil, there has been a striking increase during 1920. In July, 1920, it has been quoted at $1.30 to $1.35 per pound.

Lemon-grass oil.—Prior to the war lemon-grass oil sold for about $1 per pound. During 1915, 1916, and 1917, there was some tendency toward lower prices, but in October, 1917, the price suddenly increased to $1.35 to $1.40 per pound, and this figure was maintained during 1918 and the first three quarters of 1919. In October, 1919, a further increase to $2 per pound was followed by a sudden rise in January, 1920, to $3 and later in April, to $4 to $4.50 per pound. This high level still obtained in the beginning of the third quarter of 1920. Wholesale prices for citronella and lemon-grass oils in England are shown in the table on page 38, and domestic prices in tables on pages 37 and 38.

TARIFF HISTORY.

The free list of the act of 1883 contained a specific provision for "citronella, or lemon-grass oil," and a like provision appeared in the free list of the acts of 1890, 1894, 1897, and 1909. In the act of 1913 these oils became dutiable at 20 per cent ad valorem, and the provision (par. 46) was changed to read: "Oils, distilled and essential: * * * citronella *and* lemon-grass."

TARIFF CONSIDERATIONS.

Citronella and lemon-grass oils present no important tariff problems. Neither oil is produced in the United States, nor do they compete directly with other essential oils of domestic manufacture. The imposition of a duty in the act of 1913 was apparently for the purpose of raising revenue, and since 1914 the two oils have raised an average annual revenue of $64,659.

Citronella and lemon-grass oils are largely used in the manufacture of toilet soaps, which, under the act of 1913, are dutiable at 30 per cent ad valorem (see par. 66). Citronella oil is the chemical source of *geraniol* (used in synthetic rose perfumes), while from lemon-grass oil is obtained the aldehyde, *citral*, which, on further manufacture, yields *ionone* (used in synthetic violet perfumes).

Geraniol and *ionone* are presumably dutiable at 20 per cent ad valorem under paragraph 49 of the act of 1913 as "synthetic odoriferous or aromatic substances, preparations and mixtures used in the manufacture of, but not dutiable as perfumes or cosmetics * * *." On the other hand, *citral* made by concentrating and refining lemon oil was classified as oil of lemon under the act of 1890. (In re Fritsche, 56 Fed. 819, affirming G. A. 999 (T. D. 12137).)

Exports of citronella oil from Ceylon, 1914 and 1915.

[Source: Semiannual report of Schimmel & Co., October, 1917.]

Countries.	1914	1915	Countries.	1914	1915
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
Great Britain	596,897	464,070	Straits Settlements	2,500	270
France	27,089	88,539	Japan	21,501	32,167
Germany	99,655	.....	China	28,237	34,547
Australia	108,082	105,209			
United States	529,443	899,001	Total	1,425,943	1,638,895
India	12,539	15,092			

Exports of citronella oil from Java, 1912 and 1913.

[Source: Semiannual report of Schimmel & Co., October, 1917.]

Countries.	1912	1913	Countries.	1912	1913
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
Holland	30,367	22,609	Other European	37,112	14,651
Holland (for reexport)	7,510	22,472	All other	4,094	1,104
France	14,732	46,660			
Germany	75,089	52,592	Total	169,459	166,070
United States	555	5,982			

Citronella and lemon-grass oil—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1908	Free	692,257	$222,790		$0.320	
1909	do	1,038,838	261,748		.252	
1910	do	907,016	213,568		.235	
1911	do	831,273	190,982		.230	
1912	do	1,104,967	281,577		.255	
1913	do	885,846	287,549		.325	
1914 [1]	do	231,062	79,116		.342	
1914 [2]	20 per cent	471,454	184,033	$36,806	.390	20
1915	do	865,376	307,676	61,535	.355	20
1916	do	1,051,718	386,548	77,309	.367	20
1917	do	1,082,035	445,732	89,146	.411	20
1918	do	900,853	369,234	73,846	.409	20
1919	do	549,837	246,576	49,315	.448	20
Calendar year:						
1918	do	783,045	319,734	63,947	.408	20
1919	do	572,202	280,498	56,099	.491	20
1920 [3]	do	665,751	479,347	95,869	.719	20

[1] Act of 1909, July 1 to Oct. 3, 1913.
[2] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[3] 6 months ending June 30, 1920.

Lemon-grass oil—Prices per pound, spot.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$1.05 –$1.10	April, 1918	$1.35 –$1.40
January, 1915	.95 – 1.00	July, 1918	1.40 – 1.45
April, 1915	.90 – .95	October, 1918	1.40 – 1.45
July, 1915	.82½– .87½	January, 1919	1.40 – 1.45
October, 1915	.80 – 1.00	April, 1919	1.30 – 1.35
January, 1916	.80 – 1.00	July, 1919	1.30 – 1.35
April, 1916	.80 – .85	October, 1919	2.05 – 2.15
July, 1916	.80 – .85	January, 1920	2.90 – 3.00
October, 1916	.80 – .85	April, 1920	4.00 – 4.50
January, 1917	.80 – .85	July, 1920	4.00 – 4.25
October, 1917	1.35 – 1.40	October, 1920	3.20 – 3.25
January, 1918	1.35 – 1.40		

Citronella oil, Java—Prices per pound, spot.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$1.25 –$1.30	April, 1918	$0.72½–$0.75
January, 1915	1.30 – 1.35	July, 1918	.65 – .67½
April, 1915	1.30 – 1.35	October, 1918	.70 – .75
July, 1915	1.05 – 1.10	January, 1919	.65 – .70
October, 1915	1.00 – 1.05	April, 1919	.65 – .70
January, 1916	.90 – .95	July, 1919	.65 – .70
April, 1916	.90 – .95	October, 1919	.90 – 1.00
July, 1916	.90 – .95	January, 1920	.90 – .92½
October, 1916	.85 – .87½	April, 1920	1.10 – 1.20
January, 1917	.80 – .85	July, 1920	1.30 – 1.35
October, 1917	.82½– .85	October, 1920	1.30 – 1.35
January, 1918	.82½– .85		

Citronella oil, cans—Prices per pound, spot.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$0.49–$0.50	April, 1918	$0.52–$0.53
January, 1915	.44– .45	July, 1918	.51– .52
April, 1915	.44– .45	October, 1918	.51– .52
July, 1915	.45– .46	January, 1919	.51– .52
October, 1915	.41– .42	April, 1919	.48– .49
January, 1916	.43– .44	July, 1919	.48– .49
April, 1916	.51– .52	October, 1919	.48– .49
July, 1916	.55– .56	January, 1920	.65– .67½
October, 1916	.51– .52	April, 1920	.79– .87½
January, 1917	.48– .50	July, 1920	.90– .92
October, 1917	.57	October, 1920	.60– .62½
January, 1918	.52– .54		

Citronella oil, Ceylon, drums—Prices per pound, spot.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$0.48–$0.49	April, 1918	$0.50 - $0.51
January, 1915	.43– .44	July, 1918	.50 – .51
April, 1915	.43– .44	October, 1918	.50 – .51
July, 1915	.44– .45	January, 1919	.48½– .50
October, 1915	.39– .40	April, 1919	.47 – .48
January, 1916	.42– .43	July, 1919	.47 – .48
April, 1916	.50– .51	October, 1919	.47 – .48
July, 1916	.54– .55	January, 1920	.65 – .67½
October, 1916	.50– .51	April, 1920	.78 – .80
January, 1917	.46– .48	July, 1920	.88 – .90
October, 1917	.54– .55	October, 1920	.57½– .60
January, 1918	.51– .52		

Citronella and lemon-grass oil—Prices per pound (wholesale) in England, 1908–1919.[1]

[From Perfumery and Essential Oil Yearbook, 1920.]

Year.	Citronella.		Lemon grass.
	Ceylon.	Java.	
1908	$0.263		
1909	.215		
1910	.225		
1911	$0.235–.253		
1912	.243–.403		
1913	.363–.443		
1914	.353–.526	$0.849–$1.092	$0.80–$0.88
1915	.353–.403	.909– 1.092	.64– .80
1916	.383–.546	.849– .909	.64– .80
1917	.423–.606	.789– .849	.72– 1.76
1918	.626–.972	.849– 1.821	1.60– 2.56
1919	.486–.849		

[1] In converting these prices to United States equivalents the value of the pound sterling has been taken at par ($4.8665).

Citronella and lemon-grass oils—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	567	Oils: * * * Citronella or lemon grass	Free.
1890	661	.....do	Do.
1894	568	.....do	Do.
1897	626	.....do	Do.
1909	639	.....do	Do.
1913	46	Oils, distilled and essential: * * * citronella and lemon-grass; * * *: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.	20 per cent.

ROSE OIL OR ATTAR OF ROSES.

(Par. 46, Act of 1913, 20 per cent ad valorem.)

SUMMARY.

Attar of roses, known also as oil, ottar, otto, or essence of rose, is one of the most important and valuable natural perfume materials. It is obtained by steam distillation of fresh rose flowers, in which it is present in extremely small amounts. On the average three to four thousand pounds of flowers are required to yield 1 pound of the essence.

The chief centers for rose-oil production are in Bulgaria and France; Germany, Algeria, Spain, and Persia have also contributed some supplies in the past. The Bulgarian industry had a marked supremacy prior to the first Balkan war (1912), since the bulk of the French rose crop was formerly used in the manufacture of rose pomades, extracts, and rose water. The three wars in which Bulgaria has participated since 1912, however, have had a marked effect on the rose industry. From an average production of about 125,000 ounces for the period 1900–1912, the output fell to 85,000 ounces in 1918 and 52,000 ounces during 1919. The French have been able to take advantage of the shortage of the Bulgarian product to some extent. The average exports of essence of rose from France, 1912–1918, amounted to about 200,000 ounces.

Natural oil of roses is not produced on a commercial scale in the United States. Artificial oil of roses and other products simulating the natural products have been made to a limited extent by manufacturers specializing in synthetic perfume materials.

Imports of attar of roses into the United States were gradually increasing prior to the war and in 1913 had reached a maximum of 133,325 ounces valued at approximately $6 an ounce. In 1917, however, only 11,235 ounces were received and the average for 1917, 1918, and 1919 was 19,584 ounces.

Attar of roses was specifically provided for in the free list of the acts of 1883 to 1909, inclusive. The act of 1913 imposed a duty of 20 per cent ad valorem. This duty yielded an average annual revenue of $32,300 for the period 1915–1919.

GENERAL INFORMATION.

PROVISION IN ACT OF 1913.

PAR. 46. "Oils, distilled and essential; * * * attar of roses; * * * 20 per cent ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph."

DESCRIPTION AND USES.

Oil of roses (otto, essence, ottar or attar of rose) is the essential oil obtained by distillation of fresh rose flowers. Of the several thousand varieties of roses, only a few are distilled for their oil. In Bulgaria, where the bulk of the rose oil of commerce is produced, the

red rose (*Rosa damascene*) is the most important variety. In the Riviera district of France *Rosa d' Hai* and *Rosa centifola* and a number of other types are used for the preparation of rose oil.

Commercial Bulgarian oil is light yellow in color, with a greenish tone, has a strong odor of fresh roses, and a mild, sweet taste. It congeals or solidifies at temperatures but slightly lower than normal, to form a soft, translucent, semisolid mass. The French and German oils contain more of the paraffin constituents (stearoptene, etc.) and are often congealed at normal temperatures.[1] The most important odoriferous constituent, from a quantitative viewpoint, is the alcohol geraniol. Citronellol, another and more odorous alcohol, is present in smaller amount. Nerol, linalool, and phenyl-ethyl alcohol are other important constituents.

Because of the high price of rose oil, adulteration has become a common practice. Sophistication by the addition of other natural products, such as palmrosa and geranium oils, or of cheap synthetic materials of similar chemical composition and character, have made it necessary to use extreme care in judging of the quality of rose oils. Geraniol and citronellol have been known to be added either to the fresh flowers before distillation or to the finished product. Empirical tests are, therefore, of doubtful value and often the oils must be judged solely by their odors.

Rose oil is used extensively in the manufacture of perfumery, especially for high-grade toilet perfumes. It is also used in cosmetics and occasionally in medicine for perfuming ointments and lotions.

PRODUCTION AND TRADE.

Bulgaria, France, and Germany furnish practically all of the attar of rose of commerce. Persia at one time was an important producer, but in recent years her output has been practically negligible. The Bulgarian rose plantations are on the slopes of the Balkan Mountains and the center of the industry is at Kezanlik. Cultivation in Bulgaria began in the seventeenth century, at a time when Persia was practically the only producer. Roses have been cultivated in southern France since 1850, and Grasse, Nice, and Cannes have become the natural perfume centers of the world. The French roses in the past have been used chiefly for the preparation of rose pomades, extracts, and rose water. The manufacture of rose oil is by no means a new industry in France, but since the outbreak of the first Balkan War (1912) the French have diverted a greater proportion of the rose crop to oil production. Extensive rose plantations were established at Miltitz near Leipzig, Germany, in 1883, and since that time the Germans have produced a high quality of rose oil. There is also a small production in Algeria and Spain.

Bulgarian production.—The following statement made by the United States consul at Sofia, in February, 1920,[2] indicates the scope of the rose industry in Bulgaria and the effect of the recent wars:

During the 12 years prior to the first Balkan War, that is, from 1900 to 1912, the manufacture of attar of roses in Bulgaria attained its highest development. During that period a large number of up-to-

[1] According to Parry, Bulgarian oils contain 10 to 20 per cent of stearoptene, while in French and German oils the content may range between 25 and 65 per cent.

[2] Daily Commerce Reports, Mar. 6, 1920, p. 1313.

date factories equipped with modern steam stills were erected. The total area planted to roses increased to more than 20,000 acres. Owing to the three wars in which Bulgaria has taken part since 1912, the industry of rose culture for the production of attar of roses has experienced a decided setback. It is estimated that the present acreage planted to roses is not more than 15,000.

The average annual production of attar of roses during the period 1900–1912 was about 126,800 ounces.[1] The production fell to 85,000 ounces in 1917; 85,000 ounces in 1918, and 52,000 ounces in 1919, and it is predicted that the present year's yield will show a further decrease.

In a typical prewar year (1904) the exports of Bulgarian oil of roses were distributed as follows:

	Ounces.
France	52,300
Germany	29,000
Turkey	21,000
England	16,600
United States and all other	36,800
Total	[1] 161,700

French production.—Recent statistics in regard to the French output of *essence de rose* are lacking, although it is known that as far back as 1900 approximately 3,000,000 kilograms of roses were treated annually in the region of Grasse, Cannes, and Nice.[2] For the period 1912–1918 the exports of rose oil from France averaged 12,409 pounds, or practically 200,000 ounces. The principal customers for French oil of rose have been Belgium, Great Britain, and Switzerland, although occasionally large quantities have been sent to the United States. During the same period France annually imported, principally from Bulgaria and the French colonies (Algeria, Tunis, and New Guinea), an average of 1,361 pounds, or about 20,000 ounces.

Methods of production.—The roses to be used in the preparation of rose oil are gathered in the early morning and picking continued only until the sun is well up, since if picked in the heat of the day there is an appreciable loss of the volatile oils. It is also necessary that the flowers be distilled within 24 hours after they are gathered, for otherwise the oil is of inferior quality. An acre yields 100 pounds of flowers every day for about three weeks.

The flowers are carried in baskets to the stills, the more primitive of which consist of large copper vessels, 3 to 5 feet in height and holding about 25 pounds of flowers and 20 gallons of water. The contents of the still are heated over a brisk fire for 1 to 1½ hours, or until about 10 liters (10.5 quarts) is distilled over. The spent flowers are removed and the hot water is used again in recharging the still. The process is repeated until 40 liters of rose water is obtained and this is then redistilled in a separate still. The oil is separated from the first 5 liters of the distillate and the 35 liters is returned to the first process.

[1] Schimmel & Co., in their semiannual reports called attention to the fact that the Bulgarian export statistics for a number of years exceeded the published statistics of production. The natural inference was that this was caused by adulteration and in that connection it was interesting to note that considerable quantities of palmrosa oil were imported, and apparently consumed in Bulgaria.

[2] Evaluation de la Production de la France, II, p. 357, Paris (1917).

In the more modern installations of Germany and France and to a limited extent in Bulgaria, steam distillation has replaced the cruder process. Much larger stills are used and these are usually steam heated. Steam is generated in a boiler and passed into the still under various pressures.

The weight of the roses required to produce 1 pound of rose oil varies with the season and the variety of the flowers used, but on the average amounts to 3,500 to 4,200 pounds. There are about 200 roses to the pound and 30 roses are required to yield one drop of attar of roses.

IMPORTS.

Imports of attar of roses had shown a tendency toward a gradual increase prior to the war, reaching a maximum in 1913 of 133,325 ounces valued at $791,370. In 1914, coincident with the imposition of a duty of 20 per cent under the act of 1913, imports dropped to 40,000 ounces. This was probably caused largely by the war conditions in Bulgaria. Although there was a slight increase to 60,000 ounces in 1915 imports since that time have fallen off considerably. The average for the three years, 1917, 1918, and 1919, was only 19,584 ounces, valued at $128,549.

During the fiscal year 1914 the imports were received from the following sources:

	Per cent.
Bulgaria	70.7
Germany	19.5
Switzerland	7.3
France	2.4
England	.1

PRICES.

The average price for natural oil of roses for 1913 and 1914 was $12.50 per ounce. With the heavy importations during the latter year, however, these high prices took a downward trend which continued during 1915. In October, 1915, the low price of $6.25 per ounce was quoted. As the war continued and labor and fuel conditions in Bulgaria and France became worse the available supplies were exhausted and the price again advanced. During 1917 the shortage became acute, and with no relief during 1918 prices rose to $25 to $28 per ounce. After the middle of 1919 the situation eased up somewhat and prices decreased slightly. During 1920 as trade was resumed with Bulgaria, additional supplies became available and prices fell to prewar levels.

Artificial attar of roses is a much cheaper product, and since 1914 has sold for $2.50 to $4 per ounce.

TARIFF HISTORY AND TARIFF CONSIDERATIONS.

Ottar, or attar of roses, was mentioned specifically in the free list in the acts of 1883, 1890, 1894, 1897, and 1909. In the act of 1913 it became dutiable (in par. 46) at 20 per cent ad valorem.

A marked decrease in the imports followed, but this was probably caused by the demoralized conditions in the principal producing countries rather than by the imposition of the duty. Attar of roses

is not produced in this country nor do we produce natural products directly competitive with it.

As a source of revenue, attar of roses is one of the more important of the essential oils. For the years 1915–1919 the average annual revenue has been $32,300. During the first six months of 1920 attar of roses yielded a revenue of $80,562.

Imports and exports of oil of rose for France, 1913 and 1917—Production in principal foreign countries.

Countries.	1913		1917	
	Quantity.	Value.	Quantity.	Value.
IMPORTS.	*Pounds.*		*Pounds.*	
Germany	337			
Bulgaria	2,088		220	
Switzerland			1,389	
French Guinea	1,142			
All other	183		29	
Total	2,750	$722,245	1,638	$487,557
EXPORTS.				
Russia	507		4	
Great Britain				
Belgium	1,971		1,162	
Switzerland	2,778			
United States	948		4,008	
Japan			44	
Brazil			192	
Algeria	95			
Tunis	110			
Spain			245	
All other	842			
Total	7,251	698,467	5,655	841,905

Imports and exports of oil of rose for France, 1912–1918—Production in principal foreign countries.

Year.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1912	9,969	$785,519	8,113	$1,278,422
1913	7,251	698,467	3,750	722,206
1914	13,669	1,316,260	1,550	298,571
1915	17,648	1,699,674	4,253	819,068
1916	27,185	3,178,131	231	56,742
1917	5,655	841,866	1,638	487,518
1918	5,485	816,390	1,466	436,373

Roses, attar of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Ounces.				*Per cent.*
1908	Free	63,794	$308,256		$4.83	
1909	do	102,416	454,808		4.44	
1910	do	57,991	222,431		3.83	
1911	do	87,949	395,975		4.50	
1912	do	109,065	580,783		5.33	
1913	do	133,325	791,370		5.94	
1914	do	33,869	257,308		7.60	
1914	20 per cent	6,585	43,692	$8,738	6.64	20.00
1915	do	60,011	252,592	50,518	4.20	20.00
1916	do	40,887	169,744	33,948	4.14	20.00
1917	do	11,235	85,673	17,134	7.62	20.00
1918	do	22,633	89,049	17,809	3.93	20.00
1919	do	24,827	210,925	42,185	8.82	20.00
1918 [1]	do	21,299	160,556	32,111	7.54	20.00
1919 [1]	do	52,931	497,021	99,404	9.39	20.00
1920 [2]	do	35,803	254,879	50,976	7.12	20.00

[1] Calendar years. [2] First 6 months.

Rose, natural—Prices per ounce.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$10.00–$12.00	January, 1918	$26.00–$28.00
January, 1915	9.00– 14.00	April, 1918	26.00– 28.00
April, 1915	8.00– 8.50	July, 1918	25.00– 28.00
July, 1915	8.00– 8.50	October, 1918	28.00
October, 1915	6.25– 8.00	January, 1919	24.00– 25.00
January, 1916	8.50– 14.00	April, 1919	21.00– 24.00
April, 1916	11.00– 14.00	July, 1919	17.50– 19.00
July, 1916	13.00	October, 1919	17.50– 19.00
October, 1916	13.00– 14.25	January, 1920	16.00
January, 1917	13.00– 15.00	April, 1920	9.00– 13.50
April, 1917	16.00	July, 1920	9.00– 13.50
July, 1917	21.00	October, 1920	9.00– 13.50
October, 1917	22.00– 25.00		

Rose, artificial—Prices per ounce.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$2.00–$3.00	April, 1918	$2.50–$3.00
January, 1915	2.75– 3.00	July, 1918	2.50– 3.00
April, 1915	2.50– 3.00	October, 1918	2.50– 3.00
July, 1915	2.50– 3.00	January, 1919	2.50– 3.00
October, 1915	2.50– 3.00	April, 1919	2.50– 4.50
January, 1916	2.50– 3.00	July, 1919	2.50– 4.00
April, 1916	2.50– 3.00	October, 1919	2.50– 4.00
July, 1916	2.50– 3.00	January, 1920	2.50– 4.00
October, 1916	2.50– 3.00	April, 1920	2.50– 4.00
January, 1917	2.75– 3.00	July, 1920	2.50– 4.00
October, 1917	2.50– 3.00	October, 1920	2.50– 4.00
January, 1918	2.50– 3.00		

Attar of roses—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	553	Attar of roses	Free.
1890	661	Oils: * * * Attar of roses, * * *	Do.
1894	568	do	Do.
1897	628	do	Do.
1909	639	do	Do.
1913	46	Oils, distilled and essential: * * * attar of roses; * * *: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.	20 per cent.

COURT AND TREASURY DECISIONS.

A synthetic product made up as nearly as possible like natural oil of rose, called "oil of rose, artificial," to distinguish it from the natural oil with which it is substantially identical in properties, was held not dutiable as a chemical compound under the act of 1897, but exempt from duty under the provision of "ottar of roses" in paragraph 626 of that act. (G. A. 5732; T. D. 25438, of 1904.)

An odoriferous essential oil perfumed with the essence of roses or other flowers was held dutiable as an essential oil under paragraph 76 of the act of 1890 and not exempt from duty as attar of roses under paragraph 661 of that act. Attar of roses of commerce was declared to be described by the recognized authorities as a volatile and highly fragrant essential oil made in Turkey and other eastern countries, also in the south of France, from the finest varieties of roses, chiefly from the damask rose, or Rosa Damascena, by distilling the leaves with water at a low temperature, the yield being very small, 150 pounds of the rose leaves yielding less, generally, than an ounce of attar or otto. It is of a yellowish color, is soluble in absolute alcohol and in acetic acid, and should congeal well in five minutes at a temperature of 54½° F.

The wholesale market price of good Turkish attar of roses at that time was said to be 25 shillings sterling per ounce, and of the French to be 1,800 francs per kilo. (G. A. 1829; T. D. 13557, of 1892.)

In decisions under the act of 1883 merchandise described as oil of rose was held dutiable as an expressed oil, rather than exempt from duty as attar of roses. (T. D. 9241, of 1889; G. A. 199; T. D. 10549, of 1890.)

OILS OF LAVENDAR AND ASPIC OR SPIKE LAVENDER.

(Par. 46, Act of 1913, 20 per cent ad valorem.)

SUMMARY.

Oils of lavender and aspic or spike lavender are essential oils produced by steam distillation of certain varieties of lavender flowers. Oil of lavender, the more expensive of the two oils, is derived from *Lavendula vera*, which grows as a wild herb on the higher slopes of the Alps, or is cultivated in England. Spike lavender (from *L. spica*), is produced principally in France and Spain. It is used in cheap perfumery, and certain varnishes and lacquers and as a common adulterant of true lavender oil. The latter oil is highly valued for its odor and is used extensively in perfumery, cosmetics, and as a flavor. To a limited extent, lavender oil and certain of its preparations are used in medicine.

Oil of lavender and spike oil are not produced in the United States, although experimental cultivation by the Department of Agriculture has demonstrated that the lavender plants can be grown successfully in this country.

A large part of the lavender oil of commerce is distilled in small copper stills heated over open fires. These stills are easily carried from place to place, since it is necessary that the oil be distilled from the flowers within a short while after they are picked. In a few of the districts of largest production the stills are permanent installations, utilizing modern methods of steam distillation. The French

production of true lavender oil has been estimated to be about 130,000 pounds.

In England the industry is on a considerably smaller scale, but the careful cultivation of the plants has resulted in the production of a high grade of oil which normally brings a higher price than does the French product.

Imports of both lavender and spike oils are combined in the official statistics, which, however, indicate an average prewar import of 153,200 pounds, valued at $208,000. Imports fell off considerably during 1914 and 1915, but averaged 144,000 pounds for the next 4-year period.

Oils of lavender and aspic or spike lavender were mentioned in the free list of the acts of 1883, 1890, 1894, 1897, and 1909. A duty of 20 per cent ad valorem was imposed in 1913. Since 1916 these oils have yielded an average annual revenue of about $50,000.

General Information.

PROVISIONS IN TARIFF ACT OF 1913.

PAR. 46. "Oils, distilled and essential; * * * lavender, and aspic or spike lavender; * * * 20 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph."

DESCRIPTION AND USES.

Oil of lavender is the volatile oil obtained by the steam distillation of the flowers of the lavender plant (*Lavendula vera*). The plant is native to southern Europe and grows as a flowering herb on the higher slopes of the Alps. It has been transplanted to several countries, and especially to England, where careful cultivation has produced plants yielding a high-grade oil. In addition to the *Lavendula vera* there are other varieties of lavender which are used in France for the preparation of the essence. One of these, a hybrid formed by crossing lavender with spike (see later), is known as *lavandin*, and it is stated that 20 per cent of the French output of lavender oil is produced from this variety. Both the variety of the plant and its source or origin are reflected in the characteristics of the oil. The French oils have an ester content of 25 to 44 per cent, while the English product falls between 7 and 10 per cent. This is often used for distinguishing the two oils, but other tests must usually be made, since enough spike oil, the principal adulterant of lavender oil, may be added to the French oil to lower its ester content to that of the more expensive English oil. This, however, affects the optical rotation, as does also adulteration with turpentine. More dangerous sophistication consists in adding artificial esters, such as ethyl citrate or phthalate, or glyceyl acetate to spike oil. Oil of lavender is a pale yellow liquid used chiefly in perfumes and flavors. The oil and several of its preparations are recognized by the United States Pharmacopœia, although the medicinal use for these articles is very limited. A "terpeneless" lavender oil, which has two and one-half to three times the strength of the natural oil, is used almost exclusively in cosmetics and as a flavoring for certain liqueurs.

Oil of lavender possesses the property of improving with age, and for this reason the oils are often set aside to mature and sold under the date of preparation.

Oil of aspic, or *spike lavender*, is distilled from the flowers of *Lavendula spica*, a related variety of lavender which grows in the lower mountainous regions of France, Spain, and Italy. It is a pale yellow oil with an odor resembling that of both lavender and rosemary oils. Spike oil, as it is sometimes called, is practically free of esters. but contains a considerable proportion of alcoholic constituents, notably linalol, camphor, and borneol. It is occasionally adulterated with turpentine, rosemary oil, or with camphor oil, and in turn is commonly used to adulterate lavender oil. It is used in cheap perfumery, in certain lacquers for china painting, and for the preparation of artists' varnishes.

PRODUCTION AND TRADE.

The lavender industry is essentially French, with the exception of the marked success obtained from the plants cultivated in England. The distillation of the oil takes place in the immediate vicinity of the crops, since it is necessary to distil the oil on the same day the flowers are harvested. For this reason portable stills are largely used in the mountainous regions of southern France, and much of the very finest lavender oil is obtained from these small, transportable, copper stills heated over an open fire. They are usually 3 or 4 feet high and 2 feet in diameter; are carried from place to place on the backs of donkeys. They are owned either by the oil buyers or are loaned to the peasants by the coal merchants for 5 to 10 francs per year.

In a few districts in France, particularly in the Ventoux Mountains, and in the factories at Barreme, Villes, and Bedoin, modern methods of steam distillation are in use. In general these methods give a greater yield of oil and a better product. According to Parry the annual production of lavender oil in France is about 130,000 pounds.

English lavender oil is distilled principally in Surrey, Suffolk, and Hertfordshire Counties; the most important centers of the industry are at Mitcham, Amethill, Hitchin, and Canterbury. Both the steam and open-fire methods of distillation are in use, and in some neighborhoods lavender flowers are distilled in stills previously used for peppermint oil. Statistics for the English industry are not available, but its production in known to be considerably smaller than that of the French industry.

About 145 pounds of true lavender flowers are required for the production of 1 pound of the oil (yield of 0.69 per cent), although yields vary considerably with the plant varieties. The yield of oil of spike lavender is reported by Parry to range between 0.5 and 1 per cent.

IMPORTS.

The imports of lavender and spike oils (not shown separately) have varied widely in recent years. The average imports for the period 1900 to 1913 were 153,200 pounds, valued at $208,000. The maximum quantity was received in 1909 and amounted to 255,134 pounds, valued at $315,041. Imports in 1913 were 227,013 pounds; in 1914 and 1915, only about one-third of this amount, and the average for 1916–1919 was 144,000 pounds, valued at $255,000. It should be noted that the lower price of spike oil tends to bring down the reported value for the imports of lavender and spike lavender oils.

Imports during the fiscal year 1914 were received from the following sources:

	Per cent.
France	58.2
Spain	23.9
Germany	17.5
England	0.4

PRICES.

True oil of lavender is much more expensive than the oil of spike lavender; prior to the war the former sold for $3.75 to $4 per pound and the latter, at about $1 per pound. The first two years of the war saw little change in the price of lavender oil, although a gradual increase started in 1916 and prices continued to rise until in the middle of 1920 the prewar price had practically trebled. The average yearly prices for this period were as follows:

	Per pound.		Per pound.
1913	$3.375	1917	$4.65
1914	3.833	1918	5.433
1915	3.521	1919	7.625
1916	3.975	1920	[1] 10.75

[1] Six months

The prices for French spike oil increased to $1.25 and $1.50 during 1915, and remained practically unchanged during 1916, 1917, and 1918. At the beginning of 1919 a rise to $1.75–$1.80 occurred, and this price held until a further increase in January, 1920, brought the price to $2.25–$2.30. During the second and third quarters of 1920 spike oil reached the highest level in its history and sold for $3 and $3.25 per pound.

TARIFF HISTORY AND CONSIDERATIONS.

Aspic, or spike lavender, and lavender oils were exempt from duty from 1883 until the act of 1913 imposed a rate of 20 per cent ad valorem.

The lavender oils present no tariff problem. They are not produced in the United States, nor are they directly competitive with any of the domestic essential oils. Since 1916 they have yielded an average annual revenue of about $50,000.

Lavender and aspic or spike lavender—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	143,422	$255,642		$1.78	
1909	do	255,134	315,041		1.23	
1910	do	101,373	148,971		1.47	
1911	do	126,683	180,232		1.42	
1912	do	162,920	268,347		1.65	
1913	do	227,013	482,779		2.13	
1914	do	28,557	57,888		2.03	
1914	20 per cent	32,084	32,779	$6,555	1.02	20.00
1915	do	67,329	117,039	23,407	1.73	20.00
1916	do	198,205	271,815	54,363	1.37	20.00
1917	do	144,663	237,081	47,416	1.63	20.00
1918	do	122,958	273,466	54,693	2.12	20.00
1919	do	111,411	250,823	50,164	2.26	20.00

Oil of lavender flowers—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$3.75–$4.00	October, 1917	$5.00–$5.50
January, 1915	3.50– 4.75	January, 1918	5.25– 5.50
April, 1915	3.50– 4.00	April, 1918	5.25– 5.50
July, 1915	3.50– 4.00	July, 1918	5.00– 5.25
October, 1915	3.25– 4.00	October, 1918	6.25– 6.50
January, 1916	4.00– 4.25	January, 1919	6.50
April, 1916	4.00– 4.25	April, 1919	7.00– 7.50
July, 1916	4.00– 4.25	July, 1919	7.50– 7.75
October, 1916	3.90– 4.25	October, 1919	9.50–10.00
January, 1917	3.90– 4.25	January, 1920	10.75–11.00
April, 1917	4.25– 4.50	April, 1920	11.00–12.00
July, 1917	5.00– 5.25	July, 1920	10.50–11.00

Oil of spike lavender—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$0.90–$1.10	January, 1918[1]	$1.25–$1.50
January, 1915	1.40– 1.50	April, 1918[1]	1.25– 1.50
April, 1915	1.10– 1.25	July, 1918[1]	1.15– 1.25
July, 1915	1.10– 1.25	October, 1918[1]	1.25– 1.35
October, 1915	1.25– 1.50	January, 1919	1.75– 1.80
January, 1916	1.25– 1.50	April, 1919	1.75– 1.80
April, 1916	1.20– 1.40	July, 1919	1.75– 1.80
July, 1916	1.20– 1.40	October, 1919	1.75– 1.80
October, 1916	1.20– 1.40	January, 1920	2.25– 2.30
January, 1917	1.20– 1.40	April, 1920	3.00– 3.25
October, 1917[1]	1.50– 1.75	July, 1920	3.00– 3.25

[1] Prices for 1918–1920 are for lavender, spike, French.

Oils of lavender and aspic, or spike lavender—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
		Oils:	
1883	560	Aspic or spike lavender	Free.
1883	573	Lavender	Do.
1890	661	Oils: * * * aspic or spike lavender, * * * lavender	Do.
1894	568	.....do	Do.
1897	626	.....do	Do.
1909	639	.....do	Do.
1913	46	Oils, distilled and essential: * * * lavender, and aspic or spike lavender; * * * *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.	20 per cent.

Court and Treasury Decisions.

Lavender oil mixed with French turpentine was held properly classified as a chemical compound under paragraph 3 of the act of 1909, and not exempt from duty as lavender oil. (Abstract 29750, T. D. 32823, of 1912.)

PEPPERMINT OIL.

(Par. 46, act of 1913, 25 cents per pound.)

Summary.

Peppermint oil is, with the exception of turpentine, the most important of the domestic volatile oils. The industry, which is one of long standing in the United States, had a reported production in 1914 of 365,000 pounds, valued at about $600,000. There has since been a considerable decline in the quantity of peppermint oil produced in this country, but because of the high prices the value of total output is now considerably in excess of a million dollars. A complete census of production has not been made since 1914, but reliable estimates indicated a production of about 275,000 pounds in 1917, and 260,000 pounds in 1919. The average domestic consumption, calculated by subtracting the exports from the sum of

the production and imports, is in the neighborhood of 300,000 pounds per year.

The United States, prior to the war, produced about one-half of the world's output of peppermint oil. The bulk of the remainder was Japanese peppermint oil, which, however, is usually considered inferior to American and European oils, for all purposes other than the preparation of menthol. The American (or English) oil is preferred for flavoring purposes and commands a somewhat higher price.

The United States maintains both an import and export trade in peppermint oil. Exports in normal times are considerably in excess of the imports. Prior to 1914 imports averaged only about 3,000 pounds, while the exports exceeded 100,000 pounds. Since 1914, however, a considerable change has taken place in the industry. Production has shown a marked decline and the imports have increased to amounts unprecedented in the history of the industry. The domestic export trade has fallen off about 50 per cent since 1916. It has been stated that the increasing imports of peppermint oil were required for the manufacture of menthol, but this is considered unlikely in view of the fact that the imports of menthol have also shown marked increase during recent years. The demand in this country and abroad for both the American and Japanese oils is probably a more logical explanation for this trade.

The specific duty of 80 cents per pound on peppermint oil imposed by the act of 1890 was changed to an ad valorem rate of 25 per cent in 1894. The return was made to a specific duty in 1897 and a duty of 50 cents per pound was provided. This was reduced in 1909 to the present rate of 25 cents per pound.

Essential oil of peppermint—Summary table.

Year.	Domestic production.	Imports for consumption.	Domestic exports.	Ratio to production (per cent).	
				Imports.	Exports.
	Pounds.	*Pounds.*	*Pounds.*		
1909	305,781	1,238	161,811	0.40	53
1910	.....	1,098	110,407	.....	.....
1911	.....	2,127	123,420	.....	.....
1912	.....	1,839	155,740	.....	.....
1913	.....	3,529	134,663	.....	.....
1914	363,991	18,794	117,809	5.18	32.4
1915	.....	9,200	184,981	.....	.....
1916	.....	17,066	154,096	.....	.....
1917	[1] 276,000	23,159	100,032	8.39	.....
1918	.....	29,360	76,247	.....	.....
1919	[2] 260,000	118,741	65,548	45.66	25.19

Year.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
				Per cent.
1909	$6,416	$619	$5.18	9.65
1910	5,697	284	5.16	4.99
1911	12,126	531	5.70	4.39
1912	11,411	459	6.21	4.03
1913	13,097	882	3.71	6.74
1914	41,367	4,698	2.20	11.36
1915	8,959	2,300	.97	25.67
1916	12,573	4,266	.73	33.93
1917	37,734	5,789	1.63	15.34
1918	28,953	7,340	.98	25.35
1919	139,466	29,685	1.18	21.23

[1] Average of estimates by three leading producers and dealers. See W. I. B. Price Bulletin No. 50.
[2] Oil, Paint, and Drug Reporter, Yearbook for 1919, page 159.

General Information.

PROVISIONS IN THE ACT OF 1913.

Par. 46. "Oils, distilled and essential, * * * peppermint, * * * 25 cents per pound."

DESCRIPTION AND USES.

Oil of peppermint is a volatile oil obtained by distillation from the flowering plant of *Mentha peperita tinne* (Fam. Labiatæ). It is a colorless liquid, having a strong odor of peppermint and a cooling taste. Pure American peppermint oil has the following characteristics:[1]

Specific gravity at 15°	0.900 to 0.915.
Optical rotation	−18° to −35°.
Refractive index	1.4600 to 1.4640.
Menthol as esters	5 to 14 per cent.
Total menthol	50 to 62 per cent.
Menthone	9 to 19 per cent.

Oil of peppermint is closely related to the other mint oils. Japanese peppermint oil is the product of another species of mint, and while closely related to peppermint oil and known in the trade as such, it is not recognized by the United States Pharmacopœia. For all purposes save the preparation of menthol,[2] it is distinctly inferior to European and American peppermint oils.

Peppermint oil is most largely used in the preparation of the well-known flavor, which finds extensive use in chewing gum, confectionery, and pharmaceutical preparations. The principal constituent of peppermint oil is menthol, a white crystalline substance largely used in medicine and perfumery. The physiological and therapeutic properties of peppermint oil depend primarily upon its content of menthol. Peppermint oil is preferred for internal use because of its more pleasant taste and it is widely employed as a gastric stimulant. Preparations recognized by the United States Pharmacopœia are water of peppermint and spirits, or essence of peppermint.

American oil of peppermint may be used for the preparation of menthol, but the bulk of this commodity is made from Japanese peppermint oil.

Turpentine oil and various cheap volatile oils, whose odors may be masked by peppermint, are commonly used as adulterants. Oil from which menthol has been separated is sometimes used to adulterate peppermint oil.

PRODUCTION AND CONSUMPTION.

The world's supply of peppermint oil is largely derived from the United States and Japan, although there is an appreciable production in England, France, Germany, and Russia. The crop both here and abroad is more or less variable and it is difficult therefore to arrive at an accurate estimate of the world's production. It may be assumed, however, that the total output per year is somewhat in

[1] Parry, E. J., The Chemistry of the Essential Oils and Artificial Perfumes, p. 214.
[2] See Tariff Information Survey for Menthol, for additional discussion of Japanese peppermint industry.

excess of 600,000 pounds, of which the United States contributes approximately 50 per cent.

Domestic production.—The domestic peppermint industry is one of long standing, and, although well established, production has been localized in comparatively few districts. Cultivation began in Wayne County, N. Y., in 1816, and this locality soon became famous for the amount and quality of its production. Peppermint was introduced into Ohio a few years later, and into St. Joseph County, Mich., in 1836. Michigan is now the center of the American industry, with Indiana ranking second. In Wayne County the production at one time reached 50,000 pounds and 4,000 acres were under cultivation. In recent years, however, production has fallen to only about one-tenth of that amount.

About 1846 the Michigan industry was benefited by the introduction of improved distilling machinery. The stills have since been frequently improved and enlarged, and at present probably equal or excel anything of the kind in the world. Single distilleries are reported to have a daily capacity of 1,000 pounds of oil.

The cultivation of peppermint in Michigan and Indiana has become a very specialized industry. It is carried on in low-lying muck lands, which form the beds of ancient lakes; they are extremely rich, but require draining, which involves considerable expense. On lands of this sort the crop may be grown for six or seven years, whereas on ordinary upland soil it is unprofitable after the second year. This muck land, while especially adapted for mint culture and also for celery and cranberry growing, does not lend itself to diversified agriculture as do the uplands of the mint-growing States.

Mint is planted in rows. It is cultivated early in the season and is then allowed to cover the ground. Considerable hand hoeing and weeding are necessary. Plants are cut with scythes or machines, partially dried in windrows, and hand distilled. The setting of the plants is carried out by machinery on the larger farms, and a single machine does the work of 10 or 15 men. On the average, 330 pounds of dried mint are required to produce 1 pound of oil, and the yield per acre runs to 12 to 50 pounds, a fair average being 35 pounds for the first year, 25 pounds the second, and 12 pounds the third, or a three-year average of 24 pounds.

Owing to the expense of preparing muck lands for mint culture, the domestic industry has come chiefly into the hands of a few large firms who operate their own distilling machinery. Many small growers also exist, however, especially in the upland sections, but usually their production is distilled at stills operated under a co-operative system. The total American acreage was estimated to be in the neighborhood of 30,000 acres in 1914.

The Bureau of Census reported production of peppermint oil in 1914 to be 363,991 pounds, valued at $601,617. This consisted of 254,793 pounds of crude and 107,198 pounds of refined oil. The 1914 production represented an increase of about 15 per cent over the 1909 production and about 100 per cent over the production of 1904. Since 1914 there has been a considerable decline in domestic production. Meldrum, in War Industries Board Price Bulletin No. 50, estimated the domestic production during 1917 at only 276,000 pounds. The production for 1919 showed a further decrease, and it was stated that only 10,000 acres were under cultivation at that time.

This decline in production has caused an appreciable increase in imports, and during 1919 and 1920 imports were in the neighborhood of 50 per cent of domestic production.

FOREIGN PRODUCTION.

Japan.—Peppermint has been cultivated in Japan since prehistoric time; the oil and the menthol, which is its chief constituent, are articles of consumption, the importance of which has increased rapidly in recent years.

Hokkaido, Okayam, and Hiroshima produced about 90 per cent of the Japanese output. The latter two districts, however, which are in the southern portion of the main island of Japan, formerly predominated, but here the crop has in recent years proved somewhat less profitable than rice, and its production has suffered accordingly. Either two or three crops of the peppermint herb are harvested each year. The herb is dried carefully and distilled by the farmer and also by buyers. By far the largest proportion of the production of peppermint oil is used for the production of menthol, which is separated from the crude distillate by refrigeration.

Peppermint oil has been exported from Japan in considerable quantities since 1880. The exported oil is used chiefly for menthol production, although the United States prefers to import its menthol as such. (Production statistics are shown on p. 56.)

England.—The earliest recorded commercial peppermint culture (outside the Orient) was begun at Mitcham, England, in 1750. In 1800 about 100 acres were in peppermint, and the oil was distilled in London. In 1850 about 500 acres were planted. After that time the English industry declined rapidly, owing chiefly to American competition, being reduced to 250 acres in 1865. Since that time it has continued with considerable fluctuation and would appear not usually to exceed 500 or 600 acres. The plant cultivated at Mitcham is the black mint, and the oil derived therefrom is exceptionally fine. Mitcham oil has been generally the most expensive of peppermint oils, but its quality has been of late years closely approached or equaled by the American product. Mitcham is still the center of the English industry, but an approximately equal acreage is now planted in other localities.

Production is carried on both by small landholders and by commercial firms. Distillation is carried on both in small outdoor stills and in larger establishments, holding a ton or more at a charge, owned by the larger firms. The oil yield of English mint is comparatively small—10 to 15 pounds, rarely 25 pounds, per acre. The output of Mitcham oil runs from 8,000 to 10,000 pounds annually, and probably an equivalent amount is produced elsewhere in England. The amount of "English oil" appearing in trade is said frequently to be double the amount which can be accounted for by the imports, owing to extensive substitution by American and other oils. The high quality of English peppermint oil is considered due rather to careful selection of plants than to superior methods of culture or distillation.

France.—French peppermint is grown chiefly for local use, and little is exported, although the oil is of high quality. Centers of production are the districts of the Alpes Maritimes, Montagnes Noires,

Grasse, and La Colle. French production is estimated by Schimmel & Co. at 6,600 pounds.

Russia.—Peppermint is apparently cultivated on a large scale in Russia, although reports on this subject are at considerable variance. However, the oil is apparently distilled only on a small scale and in a primitive way. Schimmel & Co. estimates the Russian production at 26,400 pounds.

Elsewhere in Europe.—The production of peppermint oil in Germany is relatively unimportant, as that country is one of the largest importers. Italy and Sicily produced a variable amount of peppermint oil, estimated at about 8,800 pounds in 1910. Small quantities are also produced in Holland, Belgium, Sweden, Austria, and Spain.

DOMESTIC EXPORTS.

The United States has developed an export trade in peppermint oil which is considerably in excess of the imports. For the 10-year period 1909–1918 the exports averaged 131,921 pounds, valued at $314,862. Prior to the war our chief customers were Germany, England, and France. Since 1915 our exports to England and France have increased materially. In 1919 exports dropped to 65,548 pounds, the lowest figure on record in recent years.

IMPORTS.

Prior to the war the United States imported a relatively small quantity of peppermint oil, most of which was probably used for the production of menthol. In 1914 the imports increased to 18,000 pounds. In 1915 they dropped off about 9,000 pounds, and for the period 1916–1918 averaged about 23,000 pounds. During the fiscal year 1919 imports increased to the unprecedented figure of 118,741 pounds, which is at least 500 per cent more than the average prewar importations. For the 10-year period 1910–1919 imports averaged 22,491 pounds, valued at $31,104.

During the fiscal year 1914 imports of peppermint oil were received from the following sources: England, 35.8 per cent; Germany, 26.9 per cent; Japan, 23.6 per cent; France, 11.6 per cent; all others, 2.1 per cent.

PRICES.

The price of peppermint oil in general is extremely variable and has been influenced greatly by changes in planting, seasonal vicissitudes, and foreign competition. During 1913 and 1914 the trend of the price was upward. The outbreak of the war caused a brief additional advance, but because of overproduction the price receded to less than $2 per pound. During 1917 prices again showed a gradual increase, and in January, 1918, peppermint oil in tins was quoted at $3.25 per pound. Short crops and the inability to secure labor and a delay in distilling during the latter part of 1918 caused an increase to $5.25 per pound, and by April, 1919, the price had risen to $9 per pound, which may be regarded as the maximum for recent years. The high level of prices was maintained during the remaining

months of 1919 and the first half of 1920. The record of high and low prices per pound for the last nine years is as follows:

Year.	High.	Low.	Year.	High.	Low.
1911	$2.90	$2.25	1916	$2.30	$1.80
1912	2.85	2.75	1917	4.10	2.85
1913	3.85	2.75	1918	5.25	2.90
1914	4.60	1.40	1919	9.00	5.10
1915	2.00	1.35			

TARIFF HISTORY.

Peppermint oil was mentioned specifically in the tariff act of 1890 which provided a duty of 80 cents per pound. This duty in 1982 was equivalent to 69.52 per cent ad valorem. The act of 1894 reduced the rate to 25 per cent ad valorem, but in the act of 1897 return was made to a specific duty, and a rate of 50 cents per pound was provided. In 1905 the specific duty was equivalent to 43.20 per cent ad valorem. Since 1909 peppermint oil had been dutiable at 25 cents per pound and the ad valorem equivalent has varied between 4.03 per cent in 1912 and 33.93 per cent in 1916. The average ad valorem equivalent for the period 1910–1919 was 18.2 per cent.

TARIFF CONSIDERATIONS.

The relation between the rates of duty on peppermint oil and menthol is of interest. Peppermint oil (the only raw material for menthol) contains 50 to 60 per cent menthol but only 40 to 50 per cent is usually recovered. On this basis the duty of 25 cents per pound on peppermint oil would be equivalent to 50 to 55 cents per pound of menthol contained, or almost exactly equal to the present rate of duty on that commodity. (Act of 1913, paragraph 43: "Menthol, 50 cents per pound.")

Production in the United States has fallen off considerably since 1914, and there has been a corresponding increase in imports and decrease in exports. It is not entirely evident why this country maintains both an import and export trade in peppermint oil, but it is believed that both here and abroad the different characteristics of the domestic and imported oils have created demands for each of the oils.

Changes in the rate of duty have had little effect on the quantity of imports. The maximum revenue, which was received in 1918, amounted to $29,685; since 1914, however, peppermint oil has yielded an average annual revenue of only about $11,500.

Peppermint oil—Production in United States.

[Figures from Federal census.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1899	202,550	$188,559	1909	305,781	$519,079
1904	130,022	470,037	1914	363,991	601,617

Peppermint oil—Production in United States.

[Figures from Chemical and Allied Industries, Census of Manufactures, 1914.]

1909:	
Crude, 269,081 pounds	$450,981
Refined, 36,700 pounds	68,098
1914:	
Crude, 254,793 pounds	353,076
Refined, 109,198 pounds	248,541

Japanese production of oil of peppermint.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1908	89,342	$93,275	1914	326,584	$299,082
1909	143,282	156,412	1915	575,671	390,014
1910	158,203	177,440	1916	540,446	352,715
1911	165,315	223,111	1917	569,332	356,926
1912	208,076	296,835	1918	420,428	368,885
1913	274,109	330,300			

Source: Thirty-fifth Statistical Report of Agriculture and Commerce, Japan, 1920.

Peppermint oil—Imports for consumption—Revenue.

Fiscal year—	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	50 cents per pound.	2,039	$8,869	$1,019	$4.35	11.49
1909	do	1,238	6,416	619	5.18	9.65
	do	38	73	19	1.92	26.03
1910	25 cents per pound.	1,060	5,624	265	5.30	4.71
1911	do	2,127	12,126	531	5.70	4.39
1912	do	1,839	11,411	459	6.21	4.03
1913	do	3,529	13,097	882	3.71	6.74
1914	do	18,794	41,367	4,698	2.20	11.36
1915	do	9,200	8,959	2,300	.97	25.67
1916	do	17,066	12,573	4,266	.73	33.93
1917	do	23,159	37,734	5,789	1.63	15.34
1918	do	29,360	28,953	7,340	.98	25.35
1919	do	118,741	139,466	29,685	1.18	21.23
1920 (first 6 months)	do	40,551	76,656	10,137	1.88	13.25

Peppermint oil—Domestic exports (fiscal years).

Exported to—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	5,060	$8,334	4,710	$10,102	7,634	$17,425
Germany	57,310	118,023	53,815	119,411	39,733	94,557
England	81,232	128,166	41,592	66,192	65,320	132,000
Scotland	5,008	8,436	2,878	5,490	800	1,800
Canada	2,646	4,022	3,895	6,999	3,644	8,577
Australia	3,571	7,361	1,704	3,708	2,099	4,795
All other	5,984	13,976	1,813	3,943	4,190	9,880
Total	161,811	288,318	110,407	215,845	123,420	269,034

Peppermint oil—Domestic exports (fiscal years).

Exported to—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	13,195	$40,298	14,272	$43,980	8,980	$31,849
Germany	57,266	163,942	40,609	124,758	48,195	167,396
England	65,427	158,244	59,002	163,923	45,086	149,912
Scotland	3,620	11,421	1,290	3,854	1,714	5,262
Canada	3,749	11,532	8,157	25,091	5,571	19,181
Australia	2,148	6,500	2,982	9,045	3,293	7,422
All other	10,335	30,694	8,351	24,900	4,970	16,028
Total	155,740	422,631	134,663	395,551	117,809	397,050

Peppermint oil—Domestic exports (fiscal years).

Exported to—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	11,790	$23,159	27,229	$58,454	19,748	$45,077
England	97,694	193,375	80,399	163,642	49,102	101,342
Scotland	8,200	21,775	4,500	9,080	300	690
Canada	9,929	19,084	7,844	14,376	15,131	33,428
Australia	1,192	3,197	1,972	5,143	803	2,220
All other	56,176	124,003	32,152	72,375	14,948	35,870
Total	184,981	384,593	154,096	323,070	100,032	218,627

Peppermint oil—Domestic exports (fiscal years).

Exported to—	1918		1919		1920	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	11,387	$34,318	4,331	$25,555	.....	.....
England	32,228	96,684	17,621	99,458	.....	.....
Canada	16,784	49,096	20,806	102,732	.....	.....
Australia	5,571	17,545	3,944	14,363	.....	.....
All other	10,277	36,256	18,846	82,962	.....	.....
Total	76,247	233,899	65,548	325,070	90,255	677,695

Peppermint leaves (American)—Prices per pound, wholesale, New York, 1912–1920.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
Jan. 1, 1912	10–12	July 3, 1916	16–18
Apr. 1, 1912	10–12	Oct. 2, 1916	14–16
July 1, 1912	11–12	Jan. 1, 1917	14–16
Sept. 30, 1912	11–12	Apr. 2, 1917	16–18
Dec. 30, 1912	11–12	July 2, 1917	16–18
Mar. 31, 1913	11–12	Oct. 1, 1917	15–17
June 30, 1913	11–12	Jan. 1, 1918	25–28
Sept. 29, 1913	11–12	April, 1918	25–28
Dec. 29, 1913	11–12	July, 1918	25–30
Mar. 30, 1914	11–12	October, 1918	25
June 30, 1914	11–12	January, 1919	25
Sept. 28, 1914	12–14	April, 1919	25
Dec. 28, 1914	12–14	July, 1919	30
Mar. 29, 1915	12–14	October, 1919	30
June 28, 1915	12 14	Jan. 1, 1920	28–30
Sept. 27, 1915	12 14	Apr. 1, 1920	28–30
Jan. 1, 1916	12–14	July, 1920	30–33
Apr. 3, 1916	16–18	October, 1920	30–33

Essential oils, peppermint, tins—Prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$2.85–$2.95	July, 1916	$1.80–$1.85
Apr. 1, 1912	2.85– 3.00	October, 1916	2.30– 2.40
July 1, 1912	2.75– 2.90	January, 1917	2.15– 2.25
Sept. 30, 1912	2.85– 3.00	Apr. 2, 1917	2.25– 2.30
Dec. 30, 1912	2.80– 2.90	July, 1917	2.75– 2.85
Mar. 29, 1913	2.85– 3.00	October, 1917	3.55– 3.60
June 30, 1913	2.85– 3.00	January, 1918	3.25– 3.30
Sept. 29, 1913	3.85– 3.90	April, 1918	2.90– 3.00
Dec. 29, 1913	3.60– 3.80	July, 1918	3.15– 3.35
Mar. 30, 1914	4.25– 4.50	October, 1918	5.10– 5.25
June 29, 1914	4.00– 4.25	January, 1919	5.10– 5.20
August, 1914	2.75– 3.10	April, 1919	9.00
October, 1914	1.85– 2.00	July, 1919	6.50– 8.50
January, 1915	1.35– 1.40	October, 1919	7.75
April, 1915	1.55– 1.60	January, 1920	8.00
July, 1915	1.60– 1.65	April, 1920	8.25– 8.50
October, 1915	1.60– 1.65	July, 1920	7.00– 7.50
January, 1916	1.95– 2.10	October, 1920	6.50– 6.75
April, 1916	1.95– 2.10		

Essential oils—Peppermint, branded bottles—Prices per pound, wholesale, New York, spot.

[Data from Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$3.25–$3.50	July, 1916	$2.65–$2.70
Apr. 1, 1912	3.35– 3.50	October, 1916	2.85– 2.90
July 1, 1912	3.35– 3.50	January, 1917	2.85– 2.90
Sept. 30, 1912	3.25– 3.50	Apr. 2, 1917	2.85– 2.90
Dec. 30, 1912	3.35– 3.40	July, 1917	3.00– 3.10
Mar. 29, 1913	3.30– 3.40	October, 1917	3.90– 4.00
June 30, 1913	3.30– 3.40	January, 1918	4.10
Sept. 29, 1913	4.10– 4.20	April, 1918	4.00– 4.10
Dec. 29, 1913	3.90– 4.00	July, 1918	4.10
Mar. 30, 1914	4.60– 4.75	October, 1918	6.25– 6.50
June 29, 1914	4.60– 4.75	January, 1919	6.25– 6.50
August, 1914	4.15– 4.20	April, 1919	10.00–10.25
Oct. 1, 1914	3.00– 3.25	July, 1919	10.00–10.25
January, 1915	2.50– 2.60	October, 1919	(1)
April, 1915	2.45– 2.50	January, 1920	10.50–10.75
July, 1915	2.45– 2.50	April, 1920	11.00
October, 1915	2.45– 2.50	July, 1920	(1)
January, 1916	2.60– 2.65	October, 1919	(1)
April, 1916	2.65– 2.70		

[1] Nominal.

Peppermint oil—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	92	All preparations known as essential oils, * * * distilled oils, rendered oils, * * * and all combinations of any of the foregoing.	25 per cent.
1890	45	Peppermint oil	80 cents per pound.
1894	33	.....do	25 per cent.
1897	41	.....do	50 cents per pound.
1909	39	.....do	25 cents per pound.
1913	46	Oils, distilled and essential: * * * peppermint	Do.

EUCALYPTUS OIL, EUCALYPTOL, EUCALYPTUS LEAVES, AND KINO, OR EUCALYPTUS GUM.

SUMMARY.

The eucalyptus oils are essential oils distilled from the leaves of the eucalyptus tree. The tree is native to Australia which is the center of the distillation industry. One variety of eucalyptus oil is valued for its content of the alcohol *eucalyptol* and is in considerable demand for pharmaceutical purposes. In Australia a lower grade of oil, somewhat similar to pine oil, is used in large quantities in the flotation process for concentrating various sulphide ores. In the United States crude petroleum, creosote, and pine oils are available for this purpose and little, if any, eucalyptus oil is used.

Eucalyptus leaves when dried are an article of commerce used for medicinal purposes. Domestic consumption of this article is supplied almost entirely by the Californian product. An astringent gum or exudation from the eucalyptus tree is known as *kino* or eucalyptus gum. It is largely used abroad in compounding medicines, but there is little or no domestic consumption.

The eucalyptus tree was introduced into California about 1850 and is now grown on a large scale throughout the Pacific States. The production of oil is carried on only to a small extent, however, and the bulk of our consumption is imported from Australia. The imports of oil have varied considerably in recent years. In 1909 we imported 19,669 pounds valued at $5,318, and in 1918, 269,275 pounds, valued at $97,874. The average annual import for the period 1916–1919 was 181,707 pounds.

Eucalyptus oil is not specifically enumerated in the tariff act of 1913, and since 1888 (T. D. 8651) it has been classified under the general provision for "essential and distilled oils, n. s. p. f." The duty on this class prior to 1913 was 25 per cent ad valorem and this rate was reduced to 20 per cent by the act of 1913. Revenue from eucalyptus oil in recent years has ranged from $1,329 in 1908 to $19,574 in 1918. The importance of eucalyptus oil as an article of commerce appears to warrant its mention by name in the tariff law.

GENERAL INFORMATION.

PROVISIONS IN THE ACT OF 1913.

The articles discussed in this report are not mentioned specifically in the tariff law. Eucalyptus oil has been held to be dutiable under the following general provision:

> 46. Oils, distilled and essential: * * * and all * * * essential and distilled oils * * * not specially provided for in this section, 20 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

Eucalyptus leaves and gum, if not advanced in condition, are presumably entered free of duty under paragraph 477 of the free list; if advanced in value or condition, they would presumably be dutiable under paragraph 27. These provisions, as far as they relate to these products, read as follows:

> 27. Drugs, such as * * * gums, * * * leaves, * * * which are natural or uncompounded drugs and not edible and not specially provided for in this

section, but which are advanced in value or condition by shredding, grinding, chipping, crushing, or any other process or treatment whatever beyond that essential to the proper packing of the drugs and the prevention of decay or deterioration pending manufacture, 10 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

477. Drugs, such as * * * gums, * * * leaves, * * * which are natural and uncompounded drugs and not edible and not specially provided for in this section, and are in a crude state, not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process or treatment whatever beyond that essential to the proper packing of the drugs and the prevention of decay or deterioration pending manufacture: *Provided*, That no article containing alcohol shall be admitted free of duty under this paragraph.

Eucalyptol has been classified as a chemical compound under paragraph 5 of the act of 1913 (Abstract 38963 of 1915). This provision reads as follows:

5. Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures, and salts, and combinations thereof not specially provided for in this section, 15 per centum ad valorem.

DESCRIPTION AND USES.

Eucalyptus oil is the volatile oil obtained by the steam distillation of the leaves of the eucalyptus tree. There are scores of different kinds of eucalyptus trees, so that the generic term "eucalyptus oils" is without meaning unless the species is quoted. The United States Pharmacopœia stipulates that official eucalyptus oil shall be distilled from the fresh leaves of *Eucalyptus globulus* Labillardiere (family, Myrtaceæ). Although there are at least 200 species of eucalyptus oils, two general classes are evident: (1) those valued for their content of *eucalyptol*, and (2) those valued for their content of *phellandrene*. The oils of the first class are in great demand for pharmaceutical purposes and for the manufacture of pure eucalyptol, of which, according to the United States Pharmacopœia, the official eucalyptus oil must contain 70 per cent. The oil containing chiefly *phellandrene* occurs in somewhat larger quantities and is therefore cheaper to produce. It is used in large quantities in Australia for the industrial separation by the flotation process of metallic sulphides, such as those of lead, zinc, and copper.

Eucalyptol.—Eucalyptol, or *cineol* ($C_{10}H_8O$), is a colorless liquid having a characteristic aromatic, camphoraceous odor and a pungent and spicy taste. Eucalyptus oil of high eucalyptol content is frequently used for the same purposes as eucalyptol, and commercially eucalyptol sometimes consists of nothing more than a "rectified" or highly purified eucalyptus oil. Eucalyptol is used in inhalations for diphtheria, chronic bronchitis, and asthma, and externally in antiseptic mouth washes and in remedies for skin diseases.

Eucalyptus leaves.—Eucalyptus leaves are the dried leaves of *Eucalyptus globulus*. They are sometimes known as "Blue Gum" leaves and are used in pharmaceutical preparations.

Kino, or eucalyptus gum, is an astringent exudation from the stems of various species of eucalyptus. The gum is not recognized by the United States Pharmacopœia, although it is official in Great Britain. It is employed in the treatment of throat complaints.

PRODUCTION AND TRADE.

The genus eucalyptus is indigenous to Australia and Tasmania, and is said to furnish three-fourths of the vegetation of the Australian Continent. The genus embraces some 200 species, the characteristics of which are extremely diverse. It is remarkable for the number and diversity of products which may be derived from it. Among those of importance are: Essential oils, tannins and tanning extracts, kinos and gums, natural yellow dyes, the carbohydrate raffinose, eucalyptol, and other medicinals, as well as some unimportant forms of rubber and wax.

Although a great many species of eucalyptus occur in Australia, there is only a small number from which the oil can be distilled commercially.

Eucalyptus in Australia.—Probably 50 or more different species have been worked upon one time or another for the distillation of eucalyptus oils. One species, the so-called "peppermint" eucalyptus, was discovered about 1790. This species is still used for distilling, but not to any great extent. The first commercial distillery was established in 1854, and Australian eucalyptus oil appeared in London in 1866. The distillation of the oil from *Eucalyptus globulus* contributes only a small portion of the total output of Australia, and the "globulus" oil refers to a group of closely related species of which *Eucalyptus Smithii* and *Eucalyptus polybrachtea* are of chief importance. The oils of the *phellandrene* class are obtained from a number of species, of which *Eucalyptus dives* and a form of *Eucalyptus amygdalina* are the most prominent.

The distillation of the oils is usually carried on in a rather primitive manner by small operators with portable stills of an inexpensive type, the maximum capacity of which rarely exceeds 400 gallons. Other types range upward to large and permanent or semipermanent installations with tanks holding 5,000 gallons. The larger stills are usually located near the denser groves and preferably near a navigable river or harbor. The principal localities of distillation are Tasmania, Victoria, and New South Wales, and to a less extent in Queensland, South Australia, and Kangaroo Island. Purification of the crude oil is carried on extensively at Adelaide. The yields of oil vary considerably, ranging from 4 per cent to practically nothing. Each species, however, has a constant yield and gives an oil of fairly consistent composition. The yield of the pharmaceutical oil (from *eucalyptus globulus*) ranges between 0.25 and 2 per cent, and the average is about three-fourths of 1 per cent.

Complete information regarding the production and consumption of eucalyptus oil in Australia is not available. It is known that many tons of the phellandrene oils are distilled each month in New South Wales and Victoria for domestic consumption. The exports of eucalyptus oil were valued at about $200,000 in 1913; about $105,000 in 1914–15; $180,000 in 1915–16; $300,000 in 1916–17, and $385,000 in 1917–18. The bulk of the export goes to England, although considerable quantities are shipped to the United States.

Eucalyptol is prepared from oil of eucalyptus by distillation; it is crystallized by refrigeration from the portion distilling over between 150° to 175° C. The refrigerating process is repeated several times, drawing off the excess of oil each time. Eucalyptol may also be

purified by distilling eucalyptus oil in the presence of potassium hydroxide or calcium chloride.

Kino, and the several species of eucalyptus gums are in the nature of concentrated tannins or essentials combined with resins. They are obtained by incising the tree, collecting the juice, and evaporating it in the sun. Kino is exported to England, and supplies rarely reach the United States. Australia furnishes all, or nearly all, of the kino of commerce.

EUCALYPTUS OUTSIDE OF AUSTRALIA.

United States of America.—Eucalyptus species were introduced into California in 1856, and during the last half century have aroused great interest throughout that State. Probably 100 varieties have been grown there, and the timber from some of them is becoming of considerable commercial importance. In general the eucalyptus should have a good soil and some care, for the best practical results. For more detailed accounts of timber value and soil requirements, reference should be made to Bulletin No. 35 of the Forest Service, U. S. D. A., and Bullletin No. 196 of the Agricultural Experiment Station at Berkeley, Calif.

Oil of *eucalyptus globulus* is distilled to some extent in southern California. While data are lacking, the industry apparently ranks below peppermint and far below turpentine among American essentali oils. The Californian oil is of very good quality and quite constant in character. It is used chiefly for domestic consumption, little or none being exported. Most of the eucalyptus leaves used in America are produced in California, but they are unimportant as compared with the oil. Kino from American plantations has apparently not entered the market.

Europe.—*Eucalyptus globulus* was introduced into Europe in about 1850 and first attracted attention in France, where it has been cultivated extensively in the Riviera district and where the oil is distilled in a very primitive way. The tree was introduced into Italy about 1870 and has been extensively planted in marsh lands because of the general belief in its ability to "purify" malarial regions. Its efficacy in this connection has been the subject of considerable dispute, and various explanations have been formulated for its supposed effect, none of which appear to stand on any certain scientific basis.

Asia.—Several eucalypts have been introduced into India and Ceylon as ornamentals and also to a less extent for timber purposes. Occasional production of oil is reported in India.

Africa.—*Eucalyptus globulus* was introduced into Algeria about the middle of the nineteenth century and with other related species has become extremely common, often forming small forests. The eucalyptus-oil industry in Algeria is probably second only to that in Australia.

IMPORTS.

The imports of eucalyptus oil have shown considerable variation in recent years, ranging from less than 20,000 pounds in 1909 to 269,275 pounds, valued at $97,874, in 1918. The maximum import prior to the war was received in 1911 and amounted to 96,038 pounds, valued at $24,171. In 1914 imports amounted to 68,053 pounds, valued at $21,079, and were received from the following sources:[1]

[1] Miscellaneous Series No. 32. Department of Commerce, p. 111.

	Per cent.
Australia	71.3
England (probably reshipped from Australia)	28.1
Germany	0.6

The imports exceeded 200,000 pounds in 1917–18, but for the fiscal year 1919 dropped to 116,781 pounds, valued at $43,639.

Imports of eucalyptus leaves are not shown separately in Commerce and Navigation, and a publication of the Department of Commerce (Misc. Series 82) states that 21,509 pounds, valued at $317, were received from France during 1914. Imports of kino gum are not shown separately.

PRICES.

Prior to the war Australian eucalyptus oil sold for about 40 to 45 cents per pound. A slight increase (45 to 55 cents) occurred at the outbreak of the war, but by November, 1914, the price had returned to its former level. During 1915 there were considerable arrivals from Australia and the price dropped as low as 37½ cents per pound. The highest price was reached in January, 1920, when eucalyptus oil was quoted at $1 per pound.

The prewar price of eucalyptol was in the neighborhood of 75 cents per pound. During 1915–16 this price fell to about 65 cents, but in the middle of 1916 there was a sharp increase and quotations reached $1 per pound. The price continued to increase until the middle of 1919. From $1.35 per pound in April of that year, the price fell to $1.15 in July and October. The highest prices quoted for eucalyptol obtained during the first half of 1920, quotations averaging $1.65 to $1.75 per pound.

Eucalyptus leaves sold for about 4 cents per pound prior to the outbreak of the war. This price was practically doubled during the last quarter of 1914. Although the price fell to about 5 cents during the early part of 1916, it increased to 7 to 9 cents during 1917. By the middle of 1918 eucalyptus leaves were quoted at 10 cents per pound, which price has been maintained with little variation throughout the first half of 1920.

TARIFF HISTORY.

The articles discussed in this report were not specifically enumerated in the act of 1883, nor have they been mentioned by name in any of the subsequent tariff acts. The most important, *eucalyptus oil*, was classified in 1888 under a general provision for "essential oils, n. s. p. f.," in the act of 1883, dutiable at 25 per cent ad valorem. This rate (for "all other essential and distilled oils") remained unchanged until reduced by the act of 1913 to 20 per cent ad valorem.

TARIFF CONSIDERATIONS.

Imports of the eucalyptus leaves and kino, or eucalyptus gum, have been very small and of practically no significance. Imports of eucalyptus oil are not competitive with domestic production, which is on a small scale, supplying only an insignificant portion of our consumption. The imports are practically all of the quality used for pharmaceutical purposes. In this country crude petroleum, creosote,

OTHER ESSENTIAL AND DISTILLED OILS.

[Pars. 46 and 561, act of 1913.]

SUMMARY.

The essential and distilled oils discussed in this chapter are amber, anise or anise seed, chamomile, cajeput, caraway, cassia, cinnamon, fennel, jasmine, juniper, mace and nutmeg, origanum, rosemary, thyme, and valerian oils, as well as "fruit ethers, oils, and essences," and "essential and distilled oils and combinations of the same," n. s. p. f.

Essential, volatile, or ethereal oils are organic substances, generally obtained from vegetable sources and possessing, in a concentrated form, the odor or taste of the materials from which they are derived. They are called "distilled" oils because their usual method of preparation is by a distillation process. The fruit ethers, oils, and essences are generally synthetic chemical products, capable of producing odors and tastes similar to those of the different fruits. These synthetic essences as well as the natural oils are chiefly used in the manufacture of perfumery and flavoring extracts. Certain of the essential oils possess germicidal or other therapeutic properties, and are used in medicines and pharmaceutical preparations.

Practically all of the natural oils discussed herewith are of foreign origin, although at times small quantities are probably produced in this country from imported raw materials. Domestic manufacture of the synthetic essences has been carried on to a small extent for a number of years, but prior to the war most of these materials were received from Germany. France is the principal source for our supply of the natural essential oils, Italy ranks second, and considerable quantities are also obtained from Germany, Spain, and the East and West Indies.

Imports of all essential and distilled oils prior to the war had increased from $2,118,102 in 1910 to $4,905,157 in 1913. The imports then declined until 1916, from which time they showed a gradual increase to $3,942,644 in 1918. In 1919 the total had fallen off slightly and amounted to $3,678,032. In 1913, 80 per cent of the imports were entered free of duty; in 1919 imports valued at $3,625,753, or over 98.5 per cent of the total, were dutiable. Import statistics for these oils are given in the more detailed discussions of the individual oils.

Most of the essential oils included in this chapter were mentioned specifically on the free lists of the acts of 1883, 1890, 1894, 1897, and 1909. Essential and distilled oils, n. s. p. f. and the fruit ethers, oils, and essences, however, were dutiable under the act of 1883—the former at 25 per cent ad valorem and the latter at $2.50 per pound. The duty on fruit essences was reduced to $2 per pound in 1894 and to $1 per pound in 1909. Under the act of 1913 all essential and distilled oils, with the exceptions of birchtar, cajeput, ichthyol, and juglandium, were made dutiable under paragraph 46. Of the oils considered in this report, mace oil received a duty of 6 cents per pound, and the other oils, as well as the fruit ethers, oils, and essences and the essential and distilled oils n. s. p. f., were given a uniform rate of 20 per cent ad valorem. Oils of birchtar, cajeput, ichthyol, and juglandium—all of lesser industrial importance—are enumerated specifically in paragraph 561 of the free list.

The essential and distilled oils in the past have been an important source of revenue; the total revenue increased from $186,064 in 1910 to $705,777 in 1918. Prior to 1914 the classification "All other distilled and essential oils and combinations of" (dutiable at 25 per cent), yielded the largest proportion of the revenue. The rate on this classification was reduced to 20 per cent by the act of 1913, but because of the general rise in prices the revenue obtained has increased from $102,613 in 1908 to $242,816 in 1919.

General Information.

The following more important essential and distilled oils have been treated in separate units of the tariff information surveys:

Orange, lemon, lime, bergamot, cedrat, neroli or orange flower, and petit-grain; oil of bitter almonds; peppermint oil; citronella and lemon-grass oils; oils of lavender and aspic or spike lavender; attar of roses; eucalyptus oil; ichthyol; birchtar oil; camphor oil (see camphor); turpentine oil (see naval stores).

This survey is designed to include all other essential and distilled vegetable oils dutiable under paragraph 46 (act of 1913) or entered free of duty under paragraph 561. The following articles are briefly discussed: Amber oil; anise, staranise, and anise-seed oils; chamomile oil; cajeput oil; caraway oil; cassia oil; cinnamon oil; fennel oil; jasmine oil; juniper oil; mace and nutmeg oils; origanum oil; rosemary oil; thyme oil; valerian oil; "fruit ethers, oils, or essences n. s. p. f."; "all other essential and distilled oils and combinations of n. s. p. f."

Amber oil.—Amber oil differs from the other oils discussed in this chapter in that it is not distilled from a fresh-plant product. It is obtained by the destructive distillation of the fossil resin *amber*. The crude oil is usually purified by redistillation with water, and the product is known as "amber oil, rectified." According to Blackler,[1] commercial oil of amber is almost entirely distilled from cheap resins other than amber. It is used in medicine as a counterirritant, stimulant, and antispasmodic. Imports of amber oil prior to the war came principally from Germany. In 1913 they amounted to 18,707 pounds, valued at $1,027. In 1916 only 674 pounds were received; in 1917 the import was 7,580 pounds, valued at $2,932, and yielded a revenue of $586. The average import for the 10-year period, 1910–1919, was 8,936 pounds, valued at 15 cents per pound. Market prices for the crude oil were in the neighborhood of 12 to 15 cents prior to 1916, but since that time there has been a striking increase and in January, 1919, the price had reached $2.50 per pound. Prices have not been quoted since the beginning of 1919.

Anise and anise-seed oil.—Anise or anise-seed oil is distilled from the fruit, leaves, and bark of the staranise, a plant indigenous to Asia Minor and Egypt, and also cultivated in Russia, Spain, Malta, Greece, Bulgaria, Chile, and India. It is valued principally on account of its content of the alcohol *anethol*. As a flavoring agent it is one of the most important aromatic oils. It also possesses certain therapeutic properties which render it valuable as a remedy for colic and as a carminative and stimulant.

[1] Resins, by M. Bennett Blackler: Allen's Commercial Organic Analyses, IV, p. 21.

The anise-seed oil prepared in southern Russia was formerly valued highly in Europe but in recent years, because of gross adulteration, the German and French perfumers have preferred to import the seed rather than the oil from Russia. The variety known as *Staranise* oil came originally from Cochin China, but the colony of Tonkin or Tonquin (a French protectorate in Indo-China) now produces considerable amounts of this oil.

The exports from Tonkin in 1913 amounted to 330,000 pounds valued at approximately $500,000; in 1915 exports amounted to 164,463 pounds, and in 1916 to 143,049 pounds. During 1913 China exported 198,000 pounds, which went mostly to France and Germany. The exports of anise-seed oil from Hongkong were valued at $571,748 in 1918 and $678,819 in 1919. Great Britain took 60 per cent of the exports, the United States 27 per cent, and France and Japan most of the balance.

Prior to the war imports reached a maximum of 127,501 pounds in 1913, valued at $173,078, but decreased to only about one-third this quantity in 1914. During the following years imports increased until in 1917 there were imported 266,686 pounds, valued at $150,849, and yielding a revenue of $30,169. Imports declined somewhat during 1918–19, and for the 10-year period 1910–1919 averaged 120,700 pounds, valued at $106,058.

Wholesale prices of anise or aniseed oil have shown but little variation since 1912. The average prewar price was about $1.50 per pound, but this decreased to about $1 to $1.15 during 1916, 1917, and 1918. During 1919–20 the price returned to its prewar level.

Chamomile oil.—Chamomile oil (sometimes spelled camomile) is obtained by the distillation of the flowers of two varieties of the chamomile plant, which is indigenous to central, southern, and western Europe. The Roman chamomile oil is distilled from the plant *Anthemis nobilis*, which is cultivated to some extent in England, Germany, France, and Belgium. German chamomile oil is distilled from the flowers of *Matricaria chamomilla*. The dried flowers yield about 1 per cent of oil. Chamomile oil is used to a slight extent for flavoring, but mostly for medicinal purposes as an antispasmodic, stimulant, and carminative.

Imports have been very small. The maximum importation in recent years of 68 pounds, valued at $348, was received in 1910. Imports since the outbreak of the war have been practically negligible. Germany and England have been the principal sources for our supply of chamomile oil.

Cajeput oil.—Cajeput oil is distilled from the leaves of a small tree which grows abundantly in the Indian Archipelago and Malay Peninsula. It is distilled in a primitive manner by the natives of the Mollukka or Spice Islands of the Dutch East Indies. The oil has a strong, camphorlike odor because of its high content of the alcohol *Cineol*. It is used both internally and externally as a medicine, and in the Orient and British India it forms a constituent of many liniments valued by the native population. While the principal market for cajeput oil is in the Orient, the United States consumes considerable quantities, principally for use in a few well-established patent medicines. Cajeput oil is sometimes adulterated with French turpentine oil or with oil of rosemary. In Europe the cheaper grades of eucalyptus oil are competitive with cajeput.

Imports of cajeput oil have shown considerable variation, ranging from 9,143 pounds in 1913 to 96,626 pounds in 1916. The average for the 10-year period 1910-1919 was 31,645 pounds, valued at $9,832. Most of the imports are received from the East Indies, largely by way of Amsterdam. During the fiscal year 1914 imports were from the following sources: Netherlands, 69.9 per cent; Dutch East Indies, 24.6 per cent; Germany, 5.5 per cent.

During 1912 and the first part of 1913 cajeput oil was quoted at 50 cents per pound. This price was doubled in October, 1914, and since that time has generally ranged between 80 cents and $1 per pound.

Caraway oil.—Caraway oil is obtained by steam distillation from caraway seed, the fruit of a plant cultivated principally in Holland, England, and Germany. The Dutch seed are valued highly and the Dutch caraway oil is worth more than that of any other, with the possible exception of the English. It has been stated by Schimmel & Co. that in 1911, 0.9 per cent of the whole of Holland was under cultivation for caraway. The acreage in 1913 was 13,800 acres; in 1914, 13,200, and in 1915, 23,800 acres. Caraway oil is used largely in flavoring foods. It is valued on its content of the ketone, caravone, of which—according to the United States Pharmacopoeia IX—it should contain not less than 50 per cent by volume. It is used to impart flavor to certain medicines and to counteract their nauseating and griping effects.

Imports had decreased prior to the war from 60,000 pounds in 1910, to 10,107 in 1913. They amounted in 1914 to only 3,600 pounds. In 1915, 18,107 pounds were imported valued at $20,730 and yielding a revenue of $4,146. A similar quantity was imported in 1916, but since that time imports have shown a marked decrease. The average dutiable value for the 10-year period, 1910–1919, was 95 cents per pound.

Prior to the war caraway seed were quoted at about $1 per pound, but in 1916 this price was doubled and continued to increase until in October, 1917, a maximum of $8.50 per pound was reached. This high level continued during 1918–1919, but by the middle of 1920 the price had fallen to about $3.50 per pound.

Oil of Cassia.—Cassia oil (which is sometimes known as Chinese cinnamon oil) is distilled from the bark, leaves, and twigs of the cinnamon plant. The oil consists chiefly of *cinnamic aldehyde*, and usually contains from 75 to 85 per cent of this constituent. Cinnamic aldehyde can be made synthetically from coal-tar, and synthetic cassia oil is now a common article of commerce.

The exports of cassia oil from Hongkong were valued at $370,792 in 1919, as compared with $434,245 in 1918. In 1919, the United States took 55 per cent of the cassia oil; Great Britain, 21 per cent; Japan, 15 per cent, and India, practically all of the remainder. During the first quarter of 1920, the exports of cassia oil to the United States were valued at $64,511. (Daily Commerce Reports, No. 56, p. 906 (1914), and No. 128, p. 1252 (1920).)

Cassia oil is normally cheaper than the Ceylon cinnamon oil and is generally preferred in the United States. It is frequently grossly adulterated with a mixture of petroleum and rosin. It is used primarily for flavoring and as a substitute for oil of cinnamon.

Imports are combined with oil of cinnamon (see later).

Two grades of cassia oil are usually included in the price quotations: Cassia oil, 75 to 85 per cent technical, formerly sold for about $1 per pound, but since 1916, the price has ranged from $1.05 in October to $2.80 in January, 1919. Cassia oil, redistilled (U. S. Pharmacopœia) sold for about $1.40 per pound prior to 1914. The price for this grade increased to $2 in 1917, and reached a maximum of $3.50 in January, 1919. In July, 1920, it was quoted at $2.50 per pound.

Cinnamon oil.—True cinnamon oil (which is often known as oil of Ceylon cinnamon), is usually distilled from the inferior grades of cinnamon bark, which are not of sufficient value to pay export tax. The product yields from 0.5 to 1 per cent of oil. Ceylon cinnamon oil is now made in Germany, and other countries to some extent, from chips and wastes of cinnamon bark. Cinnamon leaf oil is an essential oil distilled from the leaves of the Ceylon cinnamon tree. It differs from oil of cinnamon in that it contains very little cinnamic aldehyde and from 70 to 90 per cent of eugenol.

The export of cinnamon oil from Ceylon in 1917 [1] amounted to 78,438 ounces valued at $12,950, and was distributed as follows: Straits Settlements, 35,028 ounces; United States, 30,660 ounces; France, 10,350 ounces; Great Britain, 800 ounces.

Oil of cinnamon has a finer odor than oil of cassia, and is generally preferred for perfuming purposes. It is also used to some extent in medicine.

Prior to the war Ceylon cinnamon oil sold for $6.50 to $14 per pound. Late in 1916, the price increased to about $20 per pound and this price, with slight increases, was maintained during 1917, 1918, and most of 1919. Since October, 1919, however, oil of Ceylon cinnamon has been quoted at $28 per pound.

The combined imports of cassia and cinnamon oils in 1912 were 142,182 pounds valued at $101,056 and were admitted free of duty. In 1914 and 1915 imports had fallen to less than 100,000 pounds, but for the 10-year period 1910–1919 they averaged 109,496 pounds valued at $95,334.

Imports in 1914 were received from the following sources:

	Per cent.
Hongkong	92.3 (oil of cassia.)
Netherlands	4.4
Germany	2.6
England	.6
Japan	.1

Fennel oil.—Fennel oil is distilled from the ripe fruit of fennel, a plant found in Europe, especially in the countries bordering on the Mediterranean. The principal varieties recognized in commerce are: Saxon, Galician, Moravian, and Rumanian. Of the two general types—sweet and bitter—the sweet fennel oil is generally preferred. The normal yield varies from 4 to 6½ per cent. Fennel oil is used for flavoring medicines, liqueurs, and perfumeries. It is also used to a slight extent in flavoring soaps.

Imports prior to the war had decreased from 18,421 pounds in 1908, to 4,078 pounds in 1914. In 1917, there were no imports and in 1915, 1916 and 1919 imports were less than 1,000 pounds. The average

[1] The Oil and Color Trades Journal, Dec. 14, 1918. p. 1979.

annual imports for the 10-year period, 1910–1919, were 3,751 pounds valued at $1,936.

Fennel seed oil sold for about $1.50 to $2 per pound prior to 1914, but in October of that year, the price increased to $2.75 per pound. Further increases in 1915 and 1916 brought the price up to $4.50 per pound, which was maintained, with slight variation, through 1917 and 1919. Since the middle of 1919 this price has fallen off somewhat, and during the first half of 1920 fennel seed oil was quoted at $2.75 to $3 per pound.

Jasmine or Jasimine oil.—Jasmine or jasimine oil is obtained by the cold enfleurage process from the flowers of the common white jasmine, which are grown for this purpose chiefly in the southern part of France. It is usually known commercially, however, in the form of pomades or flower extracts. Jasmine oil contains about 65 per cent of benzyl acetate, which can be made synthetically from coal tar. The odor of jasmine is therefore simulated by a number of synthetic preparations. Jasmine oil is used almost exclusively in the preparation of high grade toilet perfume. Imports of jasmine in 1913 were 3,416 pounds, valued at $39,554, and were entered free of duty. During the years 1914–1917 the annual imports averaged only about 500 pounds, valued in the neighborhood of $25 per pound. In 1918, 5,840 pounds, and in 1919, 12,227 pounds were received almost entirely from France.

Wholesale prices are not quoted in the Oil, Paint, and Drug Reporter.

Juniper oil.—Juniper oil is obtained by distilling ripe juniper berries. It is produced chiefly in Hungary where it is obtained as a by-product in the manufacture of gin. The product thus obtained is generally considered to be different from that obtained by the direct distillation of the berries. The Italian juniper berries are also valued for their content of oil, which usually amounts to 1 or 1½ per cent of the weight of the berry. Juniper wood oil, known also as cade oil, is obtained by the destructive distillation of a variety of juniper wood.

Juniper oil is used as a medicinal and for flavoring medicines. For medicinal purposes it is usually administered in the form of Holland gin. Juniper oil is used to some extent as an antiseptic chiefly for sterilizing surgical catgut.

Imports in 1913 were 17,356 pounds, valued at $13,037 and were admitted free of duty. The imports decreased during the war until in 1916 less than 1,000 pounds were received. In 1918, however, 21,346 pounds, valued at $67,147, were imported and yielded a revenue of $13,429.

Rectified oil of juniper berries was quoted at 70 cents to $1 per pound prior to the outbreak of the war. During 1915 the price showed a slight increase and in April, 1916, it reached $6.50 to $7 per pound. A continued rise brought the price up to a maximum of $16.50 during 1917. In the latter part of 1918 prices began to fall off somewhat, and by the middle of 1920 the oil was quoted at about $5 per pound.

Mace oil and oil of nutmeg.—Mace and nutmeg oils are closely related products obtained from different parts of the seed of the same plant (*Myristica fragrans*). Nutmeg oil is obtained by distilling

the kernel, or nutmeg proper, and mace oil by distilling the arillodes or outer portion of the husk which incloses the nutmeg.

The two oils are so similar that they are often sold indiscriminately. So far as known, both oils contain the same constituents, although the oil of nutmeg generally contains a larger proportion of terpenes. Nutmegs yield 8 to 15 per cent of oil of nutmeg and 4 to 15 per cent of mace oil. Expressed oil of nutmegs is often incorrectly called mace oil. These oils are generally used for flavoring, although occasionally they are used as an external stimulent and for other minor medicinal purposes.

Imports of mace oil prior to the war were rather sporadic. The maximum import in recent years was received in 1910 and amounted to 7,799 pounds, valued at $3,063. Imports in 1914–1917 varied between 3,000 and 5,000 pounds and yielded a revenue of $100 to $300 per annum. During 1918 and 1919 no imports of mace oil were reported; those of nutmeg oil are not shown in Commerce and Navigation, but according to the Department of Commerce, Miscellaneous Series No. 82, imports during the fiscal year 1914 amounted to 1,500 pounds, valued at $300, and were entirely from France.

Mace oil was quoted at about 75 cents per pound prior to the war, but increased to $1 in October, 1913. This price decreased somewhat in 1915, but gradual increases, which began in 1916, brought the price up to $2.50 per pound in April, 1918, since which time it has fallen off, and in the middle of 1920 mace oil was quoted at $1.50 per pound.

Origanum or oil of sweet marjoram.—Origanum or oil of sweet marjoram is prepared by distillation with water from the flowers and herbs of two varieties of origanum, native to Europe and America. The two principal varieties in commerce are Trieste oil, which is dark, and Smyrna oil, which is light in color. This difference in color accounts for the tariff description "red or white."

The Trieste oil is distilled from the species *Origanum hirtum*, the dried herb of which yields from 2 to 3 per cent of oil. The Smyrna oil is obtained principally from *Origanum onites*, which yields about 1½ to 2½ per cent of oil. Origanum resembles oil of thyme and is commonly substituted by this oil.

Imports of origanum had increased prior to the war to 8,822 pounds, valued at $8,502, and were admitted free of duty (1913). With the exception of the year 1914, the imports during the war have shown a remarkable increase, reaching a maximum in 1917 of 54,671 pounds, valued at $45,859, and yielding a revenue of $9,171. The total imports during 1918–19, however, amounted to only about 6,500 pounds.

Origanum oil was quoted at 17 cents per pound prior to the outbreak of the war. With the exception of a temporary increase to 22 cents in October, 1914, the price remained practically unchanged until July, 1917, at which date the oil was quoted at 30 cents per pound. Since the beginning of 1918 the price has varied between 20 cents in July, 1918, and 60 cents in July, 1920.

Rosemary or anthoss oil.[1]—Rosemary oil is distilled from the flower tops of the rosemary plant (*Rosemarinus officinalis*). The two principal varieties are the Italian or Dalmatian oil, which is distilled after

[1] The term "anthoss" is now obsolete and "Rosemary" is generally used.

the flower season is over, and the French oil, which possesses a finer odor and is distilled from the fresh flower tops. Rosemary oil is also produced in England from cultivated plants and in Spain. The production of rosemary oil in France, according to the United States Dispensatory, is in the neighborhood of 50,000 pounds. The Spanish output in 1919 was estimated to be 150 tons.[1]

Oil of rosemary is used both internally and externally in medicines, and to a considerable extent in the manufacture of perfumes.

Imports of rosemary prior to the war had shown a decided increase from 51,000 pounds in 1910 to 284,144 pounds in 1913, valued at $100,930. Imports during 1914, 1915, and 1916 were only about one-third of those in 1913, and for the 10-year period, 1910–1919, they averaged 134,172 pounds, valued at $51,327.

The French oil of rosemary flowers was quoted at 70 cents per pound prior to the war. In October, 1914, the price was increased to 85 cents to $1 per pound, and this price obtained with little variation until October, 1918. Since that time the oil has been quoted at about $1.50 per pound.

Thyme oil.—Thyme oil is distilled from the fresh flowering tops of the thyme herb, which grows abundantly in a wild state in the mountains of southern France. Small quantities are produced from the cultivated herb, but this source is of little commercial importance. One distillation of the plant yields a reddish brown oil, which is known in commerce as "red." When this product is redistilled, a colorless oil, known as "white," is obtained.

Spanish thyme oil occasionally appears on the domestic market and is probably derived from a species of origanum. The Spanish output in 1919 was estimated to be 100 tons.[1] It has been a common practice to export thyme oil from France to England, whence it is reexported to the United States as oil of origanum. Thyme oil resembles oil of origanum and has been substituted largely for the latter. Thyme oil is used chiefly for veterinary preparations and as a cheap soap perfume. The French oil is usually the most valuable. The yield of oil varies from 0.5 to 2.5 per cent.

Imports prior to the war increased from 43,384 pounds in 1908 to 138,972 pounds in 1913, valued at $105,296. During the years 1914, 1915, 1916, 1917, and 1919 the annual import was only slightly less than 100,000 pounds, valued at approximately $1 per pound. Maximum imports were received in 1918 and amounted to 206,185 pounds valued at $248,144, and yielded a revenue of $49,628.

Prices are quoted for "red" and "white" French thyme oils. The "red" oil prior to the war sold for about $1 per pound and the "white" for about $1.15 per pound. The price of the white oil increased to about $1.50 during 1915, and this price was maintained with little variation until October, 1918, when the white oil was quoted at $2 to $2.15 per pound. This price remained unchanged during 1919 and the first half of 1920. "Red" thyme oil sold for $1.30 to $1.60 per pound until the beginning of 1919, and since that time has been quoted at $1.85 to $1.90 per pound.

Oil of valerian.—Oil of valerian is distilled from the roots and rhizomes of a number of varieties of the valerian plant. Oil obtained in Europe is distilled from the roots of *valerianna officinalis* which

[1] See Supplement to Commerce Report No. 18a, Aug. 17, 1920.

grows wild throughout the northern and middle part of Europe and in Asia. Recently a variety (*augustifolia*) has been cultivated in Japan. This Japanese root yields 67 per cent of oil as compared with from 0.5 to 1 per cent of oil for the European root. The oils from the two varieties of herbs are very similar in composition and are used indiscriminately.

Imports have been extremely small and are practically negligible. Less than 100 pounds were imported prior to 1918, but in that year we received 366 pounds valued at $3,690, yielding a revenue of $738.

All fruit ethers, oils, and essences, n. s. p. f.—This provision includes all fruit ethers and essences not containing alcohol and paragraph 29 includes "ethers and esters of all kinds" (n. s. p. f.), containing not more than 10 per cent of alcohol. Paragraph 16 provides for "ethers * * * and fruit essences" containing alcohol irrespective of amount.

Chemically these fruit essences are synthetic alkyl esters of organic acids which possess the odor and flavor of certain fruits. In the older nomenclature they were improperly called "ethers" and "compound ethers"[1] and this term is still retained in the tariff provision. Among those of most importance are:

Amyl valerianate, or amyl valeric ester. (Apple essence.)
Ethyl butyrate, or ethyl butyl ester. (Pineapple essence.)
Ethyl pelargonate, or oenanthic ether. (Quince essence.)
Amyl acetate,[2] or amyl acetic ester. (Pear essence.)

Other ethyl and amyl esters are sold to simulate strawberry, raspberry, apricot, mulberry, currant, and other fruits.

The fruit essences are used for flavoring ices, jellies, lozenges, and tablets, and for making various fruit essences. (See "Flavoring Extracts" par. 49.)

All other essential and distilled oils and all combinations of the same, n. s. p. f.—The principal oils included under this classification are:

Cananga, or oil of ylang ylang.
Cade oil, or juniper wood oil.
Sandalwood oil.
Oil of rosewood.
Mustard oil.
Palmrosa or geranium-grass oil.
Geranium and geranium rose oils.

Imports classified under this provision increased in value from $410,452 in 1908, to $1,214,082 in 1919. The average import for the 10-year period, 1910–1919, was $825,838. Revenue obtained from "all other essential and distilled oils" has varied from $102,613 in 1908, to $242,816 in 1919. Import statistics are not shown separately in Commerce and Navigation but data for the individual oils imported in 1914 have been included in a publication of the Department of Commerce.[3]

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[1] U. S. Dispensatory 19th edition, p. 1497, and 20th edition, p. 1400.
[2] Amyl acetate is specifically enumerated in paragraph 29 of the act of 1913 and described in a separate unit of the Tariff Information Survey.
[3] Miscellaneous Series No. 82.

Description, uses, and import data for certain essential and distilled oils included in this report.

Name of oil.	Chief sources.	Description.	Principal uses.	Average imports for 1910–1919.		Average dutiable value (per pound).	Act of 1913.		Remarks.
				Pounds.	Value.		Paragraph.	Rate of duty.	
Amber	Distilled from the fossil resin of *Pinus succinifer*.	Brown, thin, volatile liquid.	Medicinal and pharmaceutical.	8,936	$1,373	$0.15	46	20 per cent	
Anise and aniseseed.	Distilled from fruit, leaves, and bark of *Pimpinella anisum*, *Illicum verum*, *I. religiosum*, and *I. anisatum*.	Colorless and thick liquid. Solidifies at about 15° C. Principal varieties: Staranise, Chinese, Japanese, Italian, etc.	Medicinal and as a source of anethol, used in perfumery, flavors, and liquers. Official in U.S. P. (IX).	120,700	106,058	.88	46	do	
Chamomile (German), (Roman).	Distilled from flower heads of *Matricaria chamomilla* (German), or from *Anthemis nobilis* (Roman).	Bluish liquid, with a bitter, aromatic taste.	Medicinal and in flavoring.	22	267	12.05	46	do	No imports received during 1916, 1917, and 1919.
Cajeput	Distilled from leaves of *Melaleuca leucadendron*.	Thin colorless liquid, although sometimes greenish. Camphorlike odor.	Medicinal, applied both internally and externally as a stimulant. Official in U. S. P. (IX).	31,645	9,832	.31	561	Free	
Cassia (Chinese cinnamon).	Distilled from bark of *Cinnamonum cassia*, found in China.	Yellowish or brownish liquid.	In flavoring and perfumery as a substitute for oil of cinnamon. Official in U. S. P. (IX).	109,496	95,334	.87	46	20 per cent	Imports of cassia and cinnamon are combined in official statistics.
Cinnamon (Ceylon cinnamon).	Distilled from bark of Ceylon cinnamon. (*C. zeylanicum*.)	Pale yellow oil with characteristic odor of cinnamon.	In flavoring and perfumery. (Has a finer odor than oil of cassia.) Official in U. S. P. (IX).						
Caraway	Distilled from caraway seed. (Fruit of *Carum carvi*.)	Thin, colorless or pale yellow liquid with a mild, spicy taste.	In flavoring foods and medicines. Official in U. S. P. (IX).	21,138	20,232	.95	46	do	No imports recorded in 1919.
Fennel	Distilled from fruit of *Foenieulum capillaceum* and other species.	Colorless or pale yellow liquid with a mild and spicy taste.	Medicinal, flavoring liquors, perfumery, and soap.	3,751	1,936	.52	46	do	
Jasmine	From flowers of *Jasminum grandiflorum* by the enfleurage process.	Colorless, light yellow liquid with characteristic odor.	Perfumery	3,051	48,048	15.80	46	do	
Juniper	Distilled from berries of *Juniperus communis*.	Colorless or pale greenish-yellow liquid.	In flavoring perfumery, medicines, and liquors. Official in U. S. P. (IX).	12,925	15,713	1.22	46	do	
Mace	Distilled from mace, the arillodes of the seeds of *Myristica fragrans*.	Colorless or pale greenish yellow liquid with odor of nutmegs.	Flavoring, and occasionally used in medicine. Official in U. S. P. (IX).	3,962	2,029	.51	46	6 cents per pound.	

Description, uses, and import data for certain essential and distilled oils included in this report—Continued.

Name of oil.	Chief sources.	Description.	Principal uses.	Average imports for 1910–1919.		Average dutiable value (per pound).	Act of 1913.		Remarks.
				Pounds.	Value.		Paragraph.	Rate of duty.	
Nutmeg	Distilled from nutmegs, the fruit of *M. fragrans.*	Thin, colorless, or pale yellow liquid.	Flavoring, and occasionally used in medicine. Official in U. S. P. (IX).	1,500	$300	$0.20	46 n. s. p f.	20 per cent	Import figures are for fiscal year 1914, since statistics are not shown in Commerce and Navigation. (See Comm. Dept. Misc. Series No. 82.)
Origanum, red and white.	Distilled from flowers of herbs *Origanum hirtum, O. vulgaria.*	Reddish brown or colorless liquid. Odor like oil of thyme.	Medicinal. Oil of thyme is commonly substituted for it.	11,245	10,478	.93	46	do	
Rosemary or anthoss.	Distilled from fresh flower tops of *Rosemarinus officinalis.*	Colorless or pale yellow liquid.	Medicinal and in perfumery. Official in U. S. P. (IX).	134,172	51,327	.38	46	do	
Thyme	Distilled from leaves and flowers of *Thymus vulgaris,* also from the dried herb.	Yellowish liquid with strong odor of thyme.	Medicinal and flavoring. Official in U. S. P. (IX).	97,015	93,491	.96	46	do	
Valerian	Distilled from roots and rhizomes of *Valeriana officinalis, V. celtica.* Japanese oil from var. *augustifolia.*	Thick, yellowish brown or green liquid.	Medicinal, chiefly in the treatment of nervous diseases.	76	627	8.23	46	do	No imports received during 1919.
ESSENTIAL OILS, N. S. P. F.				Imports for fiscal year 1914.					
Palmrosa or Geranium-grass (Turkish and East Indian).	Distilled from grass of certain species of *andropogon.*	Colorless or pale yellow liquid.	Perfumery	552	475	.86	46 n. s. p. f.	do	Imports are for 1914. Statistics not included in Commerce and Navigation.
Geranium-rose	Distilled from herb of species of *Pelagonium.*	Pale yellow or greenish liquid with a roselike odor.	do	63,414	146,933	2.30	46 n. s. p. f.	do	Do.
Cananga or Ylang Ylang.				6,935	17,383	2.51	46 n. s. p. f.		Do.
Cade				13,600	1,163	.09	46 n. s. p. f.		Do.
Sandalwood				7,132	14,591	2.05	46 n. s. p. f.		Do.
Mustard				13,261	12,400	.94	46 n. s. p. f.		Do.
Pine-needle				40,431	7,491	.19	46 n. s. p. f.		Do.

Imports and exports of essential oils for Great Britain—

Fiscal years.	Imports.[1]		Exports.[2]	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1908	1,841,343	$1,572,498	Not shown.	.....
1909	2,002,532	1,570,955	Not shown.	.....
1910	1,983,063	1,558,341	Not shown.	.....
1911	2,027,094	1,845,133	Not shown.	.....
1912	1,929,286	2,042,855	380,619	$501,819
1913	2,323,348	2,702,737	363,787	542,668
1914	2,286,696	2,593,431	403,824	566,052
1915	2,755,109	2,975,018	457,163	683,928
1916	2,549,339	3,084,334	536,482	861,901
1917	2,612,808	3,664,217	527,100	994,829
1918	2,053,705	4,278,203	447,373	1,320,281

[1] Natural essential oils. [2] Includes synthetic essential oils.

Exports of essential oils from France, 1912–1918—

Fiscal years.	Essence of rose.		Geranium rose (Ylang Ylang).		All other.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
1912	9,969	$785,510	174	$67,357	27,079	$6,637,463	$7,490,330
1913	7,251	696,467	179	68,708	24,041	5,893,062	6,658,237
1914	13,369	1,316,260	157	60,409	14,539	3,563,359	4,940,028
1915	8,825	1,699,751	29,304	141,063	8,355	2,560,145	4,400,979
1916	25,928	3,178,131	1,667	641,725	14,061	3,446,401	7,266,257
1917	5,655	841,866	1,012	531,715	10,306	2,779,007	4,152,588
1918	5,485	816,390	227	119,274	12,015	3,239,698	4,175,362

Imports of essential oils into France, 1912–1918—

Fiscal years.	Essence of rose.		Geranium rose (Ylang Ylang).		All other.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
1912	8,113	$1,278,432	1,629	$784,545	11,411	$3,496,388	$5,559,365
1913	3,750	722,206	1,797	865,798	13,089	4,010,540	5,598,544
1914	1,550	298,571	1,887	908,644	9,910	3,036,469	4,243,684
1915	4,253	819,092	177,111	852,674	7,915	2,425,045	4,096,811
1916	231	56,742	2,066	994,529	14,023	6,217,688	7,268,959
1917	1,638	487,518	483	316,520	14,394	4,851,441	5,655,479
1918	1,466	436,373	202	131,047	12,509	4,216,085	4,783,505

IMPORTS INTO THE UNITED STATES.

"All other" distilled and essential oils[1]*—Imports by countries (fiscal years).*

Imported from—	1914		1915	1916	1917	1918
	Free.	Dutiable.	Dutiable.	Dutiable.	Dutiable.	Dutiable.
France	$414,579	$596,103	$651,401	$718,381	$680,689	$1,209,046
Germany	76,338	346,444	138,602	17,484	.....	.....
Italy	13,644	236,732	258,519	267,895	369,015	350,013
Spain	29,111	38,286	159,384	143,860	225,177	413,051
England	34,707	114,836	133,963	113,063	202,258	204,287
Jamaica	67	54,434	46,715	54,585	147,442	225,422
British India	6,054	14,578	37,375	47,294	46,712	151,595
British East Indies	43,075	100,617	208,660	237,544	211,980	206,704
Dutch East Indies	10,325	19,771	53,846	148,897	196,905	202,210
Hongkong	17,858	61,923	157,770	324,251	268,068	197,483
Japan	.....	6,905	18,408	96,662	43,765	163,035
Australia	.....	18,888	18,995	31,399	72,550	93,377
Bulgaria	219,494	4,461	215,481	72,974	.....	.....
All other	74,065	80,494	250,046	371,282	573,616	468,064
Total	939,317	1,694,472	2,349,165	2,645,571	3,038,177	3,884,287

[1] Includes all other than lemon, birch tar, and cajeput.

Imports for consumption—Revenue.

AMBER OIL.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	9,314	$11,554	.....	$1.240	.....
1909	do	18,059	1,294	.....	.071	.....
1910	do	9,001	1,098	.....	.122	.....
1911	do	14,553	845	.....	.058	.....
1912	do	15,493	1,293	.....	.083	.....
1913	do	18,707	1,027	.....	.055	.....
1914	do	12,122	610	.....	.050	.....
	20 per cent	3,526	448	$89	.126	20
1915	do	2,720	239	47	.082	20
1916	do	674	250	50	.370	20
1917	do	7,580	2,932	586	.386	20
1918	do	1,080	458	91	.424	20
1919	do	3,900	4,530	906	1.161	20

ANISE OR ANISE-SEED OIL.[1]

1908	Free	77,704	$88,041	.....	$1.13	.....
1909	do	99,262	84,595	.....	.85	.....
1910	do	48,231	42,943	.....	.89	.....
1911	do	82,127	80,132	.....	.97	.....
1912	do	77,454	86,207	.....	1.11	.....
1913	do	127,501	173,078	.....	1.36	.....
1914	do	12,171	18,575	.....	1.53	.....
	20 per cent	30,501	37,117	$7,423	1.22	20
1915	do	117,188	119,972	23,994	1.02	20
1916	do	206,609	156,411	31,282	.75	20
1917	do	266,686	150,849	30,169	.65	20
1918	do	160,774	122,459	24,491	.76	20
1919	do	77,757	72,836	14,567	.93	20

[1] Not containing alcohol under the act of 1913.

Imports for consumption—Revenue—Continued.

CAJEPUT.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	35,107	$6,689		$0.190	
1909	do	12,687	1,687		.133	
1910	do	27,664	8,157		.295	
1911	do	22,663	8,049		.355	
1912	do	17,995	3,776		.210	
1913	do	9,143	3,224		.353	
1914	do	14,110	4,757		.337	
1915	do	19,243	6,999		.364	
1916	do	96,626	18,992		.197	
1917	do	79,585	29,585		.372	
1918	do	10,563	3,538		.335	
1919	do	18,853	11,239		.596	

CAMOMILE OIL.[1]

1908	Free	45	$356		$7.92	
1909	do	11	133		11.57	
1910	do	68	348		5.12	
1911	do	32	400		12.39	
1912	do	31	394		12.61	
1913	do	4	88		19.56	
1914	do	8	173		21.63	
	20 per cent	4	74	$14	18.50	20.00
1915	do	3	67	13	22.33	20.00
1918	do	5	60	12	12.00	20.00
1919	do					

CAMPHOR OIL.[1]

1908	25 per cent	71,722	$9,658	$2,414	$0.130	25.00
1909	do	124,354	16,818	4,204	.135	25.00
1910	do	114,710	13,874	3,468	.121	25.00
1911	do	4,088	555	138	.136	25.00
1914	20 per cent	18,874	3,160	632	.167	20.00
1915	do	68	12	2	.176	20.00
1916	do	8,333	5,708	1,141	.684	20.00
1918	do	236,000	21,245	4,249	.090	20.00
1919	do	131	56	11	.427	20.00

CASSIA AND CINNAMON OIL.[1]

1908	Free	69,652	$83,304		$1.200	
1909	do	133,194	119,343		.896	
1910	do	108,183	82,051		.758	
1911	do	80,224	56,673		.706	
1912	do	142,182	101,056		.711	
1913	do	123,645	97,438		.788	
1914	do	36,864	23,570		.639	
	20 per cent	42,291	25,958	$5,191	.614	20.00
1915	do	54,962	34,411	6,882	.626	20.00
1916	do	121,034	85,974	17,194	.710	20.00
1917	do	153,244	130,112	26,022	.848	20.00
1918	do	109,178	114,796	22,959	1.051	20.00
1919	do	123,150	201,295	40,259	1.634	20.00

CARAWAY OIL.[1]

1908	Free	22,893	$24,123		$1.05	
1909	do	16,204	19,290		1.19	
1910	do	60,007	42,560		.70	
1911	do	43,487	30,794		.70	
1912	do	30,373	21,412		.70	
1913	do	10,107	10,453		1.03	
1914	do	1,890	2,603		1.38	
	20 per cent	1,769	2,460	$492	1.39	20.00
1915	do	18,107	20,730	4,146	1.11	20.00
1916	do	15,567	23,536	4,707	1.51	20.00
1917	do	3,947	5,107	1,021	1.29	20.00
1918	do	4,992	22,432	4,486	4.49	20.00
1919	do					

[1] Not containing alcohol under the act of 1913.

Imports for consumption—Revenue—Continued.

EUCALYPTUS OIL.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	25 per cent	19,669	$5,318	$1,329	$0.270	25.00
1910	do	57,974	12,485	3,121	.215	25.00
1911	do	96,038	24,171	6,042	.252	25.00
1912	do	72,830	16,431	4,107	.226	25.00
1913	do	31,047	7,205	1,801	.232	25.00
1914	do	5,624	1,622	405	.288	25.00
	20 per cent	62,429	19,457	3,891	.312	20.00
1915	do	99,218	27,095	5,419	.273	20.00
1916	do	110,736	29,993	5,998	.270	20.00
1917	do	230,035	83,111	16,622	.361	20.00
1918	do	269,275	97,874	19,574	.363	20.00
1919	do	116,781	43,639	8,727	.382	20.00

FENNEL OIL.[1]

1908	Free	18,421	$2,944		$0.160	
1909	do	16,533	3,516		.213	
1910	do	9,896	2,609		.264	
1911	do	7,169	2,542		.354	
1912	do	6,895	2,946		.427	
1913	do	5,702	4,160		.730	
1914	do	3,248	1,521		.468	
	20 per cent	830	895	$179	1.080	20.00
1915	do	409	441	88	1.070	20.00
1916	do	610	789	157	1.290	20.00
1918	do	2,094	2,512	502	1.190	20.00
1919	do	661	942	188	1.425	20.00

FLOWER ESSENCES, LIQUID AND SOLID PRIMAL, NOT COMPOUNDED.

[Act of 1909.]

1910	Free	3,210	$31,845		$9.92	
1911	do	2,143	65,679		30.65	
1912	do	11,566	205,376		17.76	
1913	do	9,440	470,684		49.86	
1914	do	6,229	288,824		46.37	

FRUIT ETHERS, OILS, OR ESSENCES.

1908	$2 per pound	155	$176	$311	$1.13	176.83
1909	do	621	744	1,243	1.20	167.01
	do	10	24	20	2.40	83.34
1910	$1 per pound	9,882	13,574	9,882	1.38	72.80
1911	do	9,094	18,378	9,094	2.02	49.48
1912	do	390	431	390	1.10	90.63
1913	do	504	509	504	1.01	99.06
1914	do	45	56	45	1.24	80.38
	20 per cent	83	590	118	7.07	20.00
1915	do	96	406	81	4.22	20.00
1917	do	199	579	115	2.91	20.00
1918	do	132	362	72	2.74	20.00
1919	do					

FRUIT OILS OR ESSENCES ON WHICH THE SPECIFIC DUTY DOES NOT AMOUNT TO 25 PER CENT.

[Act of 1909.]

1910	25 per cent	3,352	$4,033	$1,008	$1.20	25.00
1911	do	11	734	183	66.73	25.00
1912	do	56	996	249	17.55	25.00
1913	do	18	168	42	9.02	25.00
1914	do	84	623	155	7.42	25.00

[1] Not containing alcohol under the act of 1913.

Imports for consumption—Revenue—Continued.

JASMINE OR JASIMINE OIL.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	3,606	$20,194		$5.60	
1909	do	2,338	36,865		15.76	
1910	do	2,899	31,739		10.94	
1911	do	1,851	30,766		16.62	
1912	do	2,074	29,620		14.28	
1913	do	3,416	39,554		11.58	
1913	do	380	8,345		21.96	
1914	20 per cent	231	6,015	$1,203	26.04	20.00
1915	do	261	5,160	1,032	19.77	20.00
1916	do	978	27,592	5,518	28.21	20.00
1917	do	348	8,366	1,673	24.03	20.00
1918	do	5,840	89,320	17,864	15.29	20.00
1919	do	12,227	204,005	40,801	16.58	20.00

JUNIPER OIL.[1]

1908	Free	13,950	$8,213		$0.590	
1909	do	21,647	13,521		.625	
1910	do	16,563	9,628		.581	
1911	do	21,457	10,110		.471	
1912	do	20,808	10,620		.510	
1913	do	17,356	13,037		.751	
1913	do	4,253	2,748		.646	
1914	20 per cent	10,292	5,943	$1,188	.577	20.00
1915	do	10,388	7,637	1,527	.709	20.00
1916	do	975	1,988	397	2.030	20.00
1917	do	4,661	21,514	4,302	4.610	20.00
1918	do	21,346	67,147	13,429	3.140	20.00
1919	do	1,146	6,758	1,351	5.896	20.00

MACE OIL.

1908	Free	1,850	$924		$0.499	
1909	do	2,200	983		.447	
1910	do	7,799	3,063		.393	
1911	do	2,385	1,033		.433	
1912	do	1,944	902		.464	
1913	do	5,737	2,611		.455	
1913	do	1,030	520		.504	
1914	6 cents per pound	1,622	860	$97	.530	11.28
1915	do	4,776	2,605	286	.545	11.00
1916	do	3,400	2,224	204	.654	9.17
1917	do	3,000	2,414	180	.804	7.46
1918	do					
1919	do					

ORIGANUM OIL, RED OR WHITE.[1]

1908	Free	6,976	$1,608		$0.23	
1909	do	2,657	741		.27	
1910	do	1,823	541		.29	
1911	do	849	273		.32	
1912	do	718	645		.89	
1913	do	8,822	8,502		.96	
1914	do	100	76		.76	
	20 per cent	407	554	$110	1.36	20.00
1915	do	14,349	15,111	3,022	1.05	20.00
1916	do	24,222	24,291	4,858	1.00	20.00
1917	do	54,671	45,859	9,171	.83	20.00
1918	do	3,851	3,424	684	.88	20.00
1919	do	2,637	5,506	1,101	2.08	20.00

[1] Not containing alcohol under the act of 1913.

Imports for consumption—Revenue—Continued.

ROSEMARY OR ANTHOSS OIL.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	60,826	$31,921		$0.520	
1909	do	85,421	41,792		.489	
1910	do	51,832	22,917		.442	
1911	do	94,098	42,049		.447	
1912	do	153,592	62,369		.406	
1913	do	284,144	100,930		.355	
1914	do	52,575	17,660		.336	
	20 per cent	32,668	12,517	$2,503	.383	20.00
1915	do	93,663	44,636	8,927	.476	20.00
1916	do	95,815	30,504	6,100	.318	20.00
1917	do	228,080	71,035	14,207	.311	20.00
1918	do	204,105	71,541	14,308	.350	20.00
1919	do	51,146	37,111	7,432	.725	20.00

THYME OIL.[1]

1908	Free	43,384	$37,546		$0.870	
1909	do	50,117	37,272		.744	
1910	do	46,325	32,592		.703	
1911	do	42,317	35,956		.850	
1912	do	66,039	47,862		.725	
1913	do	138,972	105,296		.758	
1914	do	40,756	32,386		.794	
	20 per cent	48,392	31,478	$6,295	.650	20.00
1915	do	99,580	88,498	17,699	.888	20.00
1916	do	92,097	85,913	17,182	.932	20.00
1917	do	91,163	90,868	18,173	.996	20.00
1918	do	206,185	248,144	49,628	1.200	20.00
1919	do	98,324	135,914	27,182	1.382	20.00

VALERIAN OIL.[1]

1908	Free	9	$74		$8.22	
1909	do	18	83		4.61	
1910	do	52	353		6.79	
1911	do	35	120		3.43	
1912	do	18	55		3.06	
1913	do	40	124		3.10	
1914	do	6	12		2.00	
1915	20 per cent	15	36	$7	2.40	20.00
1918	do	366	3,690	738	10.08	20.00
1919	do					

ALL OTHER ESSENTIAL AND DISTILLED OILS AND COMBINATIONS OF.[1]

1908	25 per cent		$410,452	$102,613		25.00
1909	do		511,444	127,861		25.00
1910	do		537,508	134,377		25.00
1911	do		620,991	155,247		25.00
1912	do		750,068	187,517		25.00
1913	do		799,785	199,946		25.00
1914	do		203,897	50,974		25.00
	20 per cent		581,010	116,202		20.00
1915	do		718,230	143,646		20.00
1916	do		752,925	150,585		20.00
1917	do		949,611	189,922		20.00
1918	do		1,130,270	226,054		20.00
1919	do		1,214,082	242,816		20.00

[1] Not containing alcohol under the act of 1913.

Imports for consumption—Revenue—Continued.

ALL OTHER ESSENTIAL OILS, ETC.

[From Philippine Islands—Acts of Mar. 3, 1905, Aug. 5, 1909, and Oct. 3, 1913.]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	75 per cent of 25 per cent.		$9,601	$1,800		18.75
1909	do		16,554	3,103		18.75
	do		1,823	341		18.75
1910	Free		26,266			
1911	do		12,555			
1912	do		20,737			
1913	do		21,610			
1914	do		16,737			
1915	do		23,366			
1916	do		14,387			
1917	do		20,707			
1918	do		33,423			
1919	do		40,639			
OILS, CONTAINING 20 PER CENT OR LESS OF ALCOHOL.						
1914	10 cents per pound plus 20 per cent.	1,281	$1,652	$458	$1.29	27.75
1915	do	102	394	89	3.86	22.59
1916	do	50	118	28	2.36	24.24
1917	do	200	296	79	1.48	26.76
1918	do	22	15	5	.68	34.67
1919	do	50	81	21	1.62	25.92
CONTAINING MORE THAN 20 AND NOT MORE THAN 50 PER CENT.						
1914	20 cents per pound plus 20 per cent.	274	$400	$134	$1.46	33.50
1915	do	125	165	58	1.32	35.15
1916	do	70	275	69	3.93	25.09
CONTAINING MORE THAN 50 PER CENT.						
1914	40 cents per pound plus 20 per cent.	352	$809	$302	$2.30	37.33
1915	do	207	904	263	4.37	29.16
1916	do	3	14	4	4.67	28.57
1917	do	100	122	64	1.22	52.79
1918	do	4	33	8	8.25	24.85

PRICES.

Amber oil, crude—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.12–$0.13	$0.12–$0.14	$0.12–$0.14	$0.12½–$0.15	$0.30–$0.35
April	.12– .14	.12– .14	.12– .14	.12½– .15	[1].90
July	.12– .14	.12– .14	.12– .14	.12½– .15	(1)
October	.12– .14	.12– .14	.15– .16	[1].20 – .25	(1)

Month.	1917	1918	1919	1920
January	[1] $1.00–$1.50	$1.40–$1.50	$2.50–$2.75	(1)
April	1.10– 1.30	1.35– 1.45	(2)	(2)
July	1.50– 1.75	2.25– 2.50	(2)	(2)
October	1.40– 1.50	(2)	(2)	

[1] Nominal.

[2] Not quoted.

Amber oil, rectified—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.20–$0.22	$0.22–$0.24	$0.32–$0.34	$0.20–$0.22½	[1] $0.50–$0.60
April	.20– .22	.22– .24	.32– .34	.20– .22½	[1] 1.65
July	.22– .24	.22– .24	.32– .34	.20– .22½	[1]
October	.22– .24	.22– .24	.25– .30	[1] .32– .35	[1]

Month.	1917	1918	1919	1920
January	$1.25–$1.60	$1.65–$1.75	[1]	[1]
April	1.30– 1.60	1.75– 1.85	[2]	[2]
July	2.00– 2.10	2.50– 2.75	[2]	[2]
October	1.75– 1.85	[2]	[2]	

[1] Nominal. [2] Not quoted.

Anise or anise seed oil—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Months.	1912	1913	1914	1915	1916
January	$1.40 –$1.45	$1.60 –$1.65	$1.65–$1.70	$1.45–$1.50	$1.05–$1.10
April	1.47½– 1.55	1.60 – 1.65	1.65– 1.70	1.25	1.05– 1.10
July	1.40 – 1.45	1.67½– 1.72½	1.60– 1.65	1.15– 1.20	1.00– 1.15
October	1.55 – 1.60	1.65 – 1.70	2.00– 2.10	1.05– 1.10	1.00– 1.15

Months.	1917	1918	1919	1920
January	$1.05–$1.15	$1.05 –$1.15	$1.50–$1.55	$1.55–$1.65
April	1.05– 1.15	1.07½– 1.10	1.45– 1.50	1.40– 1.50
July	1.05– 1.15	1.10 – 1.10	1.40– 1.50	1.00– 1.10
October	1.05– 1.15	1.15 – 1.20	1.55– 1.65	

Cajeput oil—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Months.	1912	1913	1914	1915	1916
January	[1] $0.45–$0.50	[1] $0.50–$0.55	[2]	$0.90–$1.00	$0.80–$0.85
April	[1] .45– .50	[2]	[2]	.80– .85	.80– .85
July	[1] .45– .50	[2]	[2]	.80– .85	.80– .85
October	[1] .45– .50	[2]	$1.00–$1.10	.80– .85	.75– .85

Months.	1917	1918	1919	1920
January	$0.80 –$0.85	$0.77½–$0.80	$0.80–$0.85	$0.90–$1.00
April	.80 – .85	.77½– .80	.80– .85	.80– .85
July	.77½– .80	.77½– .80	.80– .85	.80– .85
October	.77½– .80	.80 – .85	.90– 1.00	

[1] Native. [2] Not quoted.

Caraway seed oil—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.85–$1.00	$1.00–$1.10	(2)	$1.75	$2.00–$2.25
April	1.00– 1.10	1.00– 1.10	(2)	1.75	2.50– 2.75
July	1.00– 1.10	(2)	(2)	1.80– 2.00	3.00– 3.25
October	1.00– 1.10	(2)	$1.75–$2.00	1.60– 1.75	3.10– 3.25

Month.	1917	1918	1919	1920
January	$3.50–$3.75	$8.00–$8.50	$8.00–$8.25	$5.50–$6.00
April	5.50– 6.00	8.00– 8.50	7.50– 7.75	4.25– 4.50
July	7.50–[1] 9.00	8.00– 8.50	7.50– 7.75	3.50– 3.75
October	8.00– 8.50	8.00– 8.50	6.50– 7.00	.....

[1] Nominal. [2] Not quoted.

Cassia oil, 75 to 80 per cent, tech.—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.90–$0.95	$0.82½–$0.85	$0.82½–$0.85	$0.80 –$0.82½	$1.20–$1.25
April	.90– .95	.82½– .85	.82½– .85	.82½– .85	1.15– 1.20
July	.85– .90	.85	.82½– .85	.87½– .90	1.20– 1.25
October	.85– .87½	.85	1.00 – 1.10	.85 – .90	1.05– 1.10

Month.	1917	1918	1919	1920
January	$1.07½–$1.15	$1.60–$1.65	$2.75–$2.80	$2.40–$2.50
April	1.20	2.05– 2.10	2.45– 2.50	2.25– 2.50
July	1.25 – 1.30	2.25– 2.27½	1.95– 2.05	1.75– 1.85
October	1.45	2.35– 2.60	2.35– 2.45	.....

Cassia oil, redistilled (U. S. P. 1918–1920)—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$1.25–$1.40	$1.25–$1.40	$1.30–$1.40	$1.40 –$1.50	$1.65–$1.70
April	1.25– 1.40	1.25– 1.40	1.30– 1.40	1.25 – 1.35	1.65– 1.70
July	1.25– 1.40	1.30– 1.40	1.30– 1.40	1.37½– 1.40	1.75– 1.80
October	1.25– 1.40	1.30– 1.40	1.50– 1.60	1.30 – 1.35	1.65– 1.70

Month.	1917	1918	1919	1920
January	$1.60–$1.70	$2.10–$2.25	$3.35–$3.50	$3.00–$3.05
April	1.80	2.50– 2.60	3.15– 3.25	2.80– 2.85
July	1.80– 1.85	2.75– 2.80	2.50– 2.60	2.40– 2.50
October	2.00	3.00– 3.50	2.85– 2.95	.....

Cinnamon oil, Ceylon, heavy—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$6.50–$14.00	$6.50–$14.00	$6.50–$14.00	$6.00–$7.50	$12.00–$12.50
April	6.50– 14.00	6.50– 14.00	6.50– 14.00	6.00– 7.50	15.00– 15.50
July	6.50– 14.00	6.50– 14.00	6.50– 14.00	7.00– 7.25	18.00
October	6.50– 14.00	6.50– 14.00	8.00– 14.00	7.50– 8.00	20.00

Month.	1917	1918	1919	1920
January	$20.00	$20.00–$22.00	$23.00–$24.00	$28.00
April	22.00	22.00– 24.00	23.00– 24.00	28.00
July	22.00	20.00– 22.00	(1)	28.00
October	$22.00– 24.00	20.00– 22.00	28.00	.....

[1] Nominal.

Fennel-seed oil, sweet—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$1.50–$1.60	$1.50–$1.60	$1.65–$1.70	$2.50–$2.75	$3.75–$4.00
April	1.50– 1.60	1.50– 1.60	1.90– 2.00	2.50– 2.75	4.25
July	1.50– 1.60	1.50– 1.60	1.90– 2.00	2.75– 3.00	4.00– 4.25
October	1.50– 1.60	1.50– 1.60	2.50– 2.75	3.00– 3.50	4.50– 5.50

Month.	1917	1918	1919	1920
January	$4.00–$4.50	$3.75–$4.00	$3.75–$4.00	$2.75–$3.00
April	4.00– 4.50	3.75– 4.00	3.50– 3.75	2.75– 3.00
July	4.00– 4.50	3.75– 4.00	3.00– 3.75	2.75– 3.00
October	3.75– 4.00	3.75– 4.00	2.75– 3.00	.....

Oil of juniper berries, rectified—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.70–$1.00	$0.70–$1.00	$0.75–$1.00	$1.15–$1.35	$3.75–$4.00
April	.70– 1.00	.70– 1.00	.75– 1.00	1.15– 1.25	[1] 6.50– 7.00
July	.70– 1.00	.75– 1.00	.75– 1.00	1.15– 1.25	[1] 6.50– 7.00
October	.70– 1.00	.75– 1.00	1.25– 1.50	1.75	8.50

Month.	1917	1918	1919	1920
January	$15.00–$16.50	$15.00–$16.00	$10.00–$11.00	$6.25–$6.50
April	16.00– 16.50	13.00– 14.00	9.50– 9.75	[2] 6.00– 6.25
July	15.00– 16.00	12.00– 12.25	6.75– 7.00	[2] 4.75– 5.00
October	15.00– 16.00	11.00– 11.25	7.50– 8.00	.....

[1] Nominal.

[2] Juniper berries, U. S. P.

Oil of juniper berries, twice rectified—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.80–$1.00	$0.80–$1.00	$0.85–$1.00	$1.50–$1.75	$4.00–$4.50
April	.80– 1.00	.80– 1.00	.85– 1.00	1.50– 1.75	[1] 6.00– 8.00
July	.80– 1.00	.80– 1.00	.85– 1.00	1.50– 1.75	[1] 6.75– 7.25
October	.80– 1.00	.80– 1.00	1.50– 1.75	2.00	[1] 8.50

Month.	1917	1918	1919	1920
January	$16.00–$17.50	$16.50–$17.00	$11.00–$11.25	$6.25–$6.50
April	17.00– 17.50	13.50– 14.00	9.75– 10.00	[2]
July	16.50– 17.00	12.50– 13.00	[2]	.....
October	16.50– 17.00	12.50– 13.00	[2]	.....

[1] Nominal. [2] Not quoted.

Mace oil, distilled—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.65–$0.75	$0.65–$0.70	$0.65–$0.75	$0.85	$0.90 -$1.00
April	.65– .75	.65– .70	.70– .75	.85	.97½– 1.00
July	.65– .75	.65– .70	.70– .75	.90	1.15 – 1.20
October	.65– .70	.65– .75	1.00– 1.10	.90	1.05 – 1.10

Month.	1917	1918	1919	1920
January	$1.20–$1.30	$2.25–$2.50	$2.25–$2.30	$1.60–$1.65
April	1.25– 1.30	2.25– 2.50	2.10– 2.25	1.60– 1.65
July	1.50– 1.55	2.35– 2.40	1.65– 1.75	1.50– 1.55
October	1.50– 1.55	2.25– 2.30	1.65– 1.75	.....

Origanum oil—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.17–$0.45	$0.17–$0.45	$0.17–$0.45	$0.18–$0.25	$0.18–$0.25
April	.17– .45	.17– .45	.17– .45	.18– .25	.18– .25
July	.17– .45	.17– .45	.17– .45	.18– .25	.18– .25
October	.17– .45	.17– .45	.22– .23	.18– .25	.18– .25

Month.	1917	1918	1919	1920
January	$0.18–$0.25	$0.32–$0.35	$0.20–$0.50	$0.30–$0.60
April	.18– .25	.22– .35	.20– .50	.30– .60
July	.30– .35	.20– .50	.20– .50	.60– 1.00
October	.32– .35	.20– .50	.30– .60	.....

Oil of rosemary flowers, French—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.67½–$0.75	$0.67½–$0.70	$0.70–$0.75	$0.85–$1.00	$0.75–$0.85
April	.67½– .70	.67½– .70	.70– .75	.85– 1.00	.75– .85
July	.67½– .70	.67½– .70	.70– .75	.85– 1.00	.75– .85
October	.67½– .70	.60 – .70	.85– 1.00	.75– .85	.75– .85

Month.	1917	1918	1919	1920
January	$0.75–$0.85	$0.80–$0.85	$1.40–$1.50	$1.35–$1.40
April	.75– .85	.80– .85	1.40– 1.50	1.35– 1.40
July	.80– .85	.90– 1.00	1.40– 1.50	1.35– 1.40
October	.80– .85	1.50– 1.55	1.35– 1.40	.....

Thyme oil, white, French—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$1.15–$1.25	$1.15–$1.25	$1.15–$1.25	$1.10–$1.25	$1.50–$1.75
April	1.15– 1.25	1.15– 1.25	1.15– 1.25	1.50– 1.75	1.50– 1.75
July	1.15– 1.25	1.15– 1.25	1.40– 1.50	1.50– 1.75	1.50– 1.75
October	1.15– 1.25	1.15– 1.25	2.15– 2.25	1.50– 1.75	1.50– 1.75

Month.	1917	1918	1919	1920
January	$1.50–$1.75	$1.65–$1.75	$2.00–$2.15	$2.00–$2.25
April	1.50– 1.58	1.70– 1.75	2.00– 2.15	2.00– 2.25
July	1.65– 1.75	1.65– 1.75	2.00– 2.15	2.00– 2.25
October	1.65– 1.75	2.00– 2.15	2.00– 2.15	.....

Thyme oil, red, French—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$1.00–$1.10	$1.00–$1.10	$1.00–$1.10	$0.95–$1.15	$1.30–$1.60
April	1.00– 1.10	1.00– 1.10	1.00– 1.10	1.15– 1.60	1.30– 1.60
July	1.00– 1.10	1.00– 1.10	1.30– 1.40	1.30– 1.60	1.30– 1.60
October	1.00– 1.10	1.00– 1.10	1.85– 2.00	1.30– 1.60	1.30– 1.60

Month.	1917	1918	1919	1920
January	$1.30–$1.60	$1.50–$1.60	$1.85–$1.90	$1.85–$1.90
April	1.30– 1.60	1.60– 1.70	1.85– 1.90	1.85– 1.90
July	1.50– 1.60	1.50– 1.60	1.85– 1.90	1.85– 1.90
October	1.50– 1.60	1.75– 1.80	1.85– 1.90	.....

Essential and distilled oils—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	92	All preparations known as essential oils, * * * distilled oils, * * * and all combinations of the foregoing.	25 per cent.
	556	Amber, crude and rectified	Free.
	558	Anise, or anise seed	Do.
	562	Cajeput	Do.
	563	Carraway	Do.
	564	Cassia and cinnamon	Do.
	566	Chamomile	Do.
	568	Civet	Do.
	569	Fennel	Do.
	570	Jasmine or jasimine	Do.
	572	Juniper	Do.
	576	Mace	Do.
	581	Rosemary or anthoss	Do.
	583	Thyme or origanum, red or white, valerian	Do.
	114	Fruit ethers, oils, or essences	$2 50 per pound.
	557	Ambergris	Free.
1890	25	* * * fruit ethers, oils, or essences	$2.50 per pound.
	76	Products or preparations known as * * * distilled oils, essential oils, * * * and all combinations of the foregoing.	25 per cent.
	661	Oils: * * * amber, crude and rectified ambergris, anise or anise-seed, * * * cajeput, carraway, * * * cassia, cinnamon, * * * chamomile, * * * civet, fennel, jasmine or jasimine, * * * juniper, * * * mace, * * * rosemary or anthoss, * * * thyme, origanum, red or white, valerian, * * *.	Free.
1894	17	* * * fruit ethers, oils- or essences	$2 per pound.
	60	Products or preparations known as * * * distilled oils, essential oils, * * * and all combinations of the foregoing.	25 per cent.
	568	Oils: * * * amber, crude and rectified ambergris, anise or anise-seed, * * * cajeput, carraway, cassia, cinnamon, * * * chamomile, * * * civet, * * * fennel, jasmine or jasimine, * * * juniper, * * * mace, * * * rosemary or anthoss, * * * thyme, origanum, red or white, valerian.	Free.
1897	3	* * * distilled oils, essential oils, * * * and all combinations of the foregoing, * * * not specially provided for in this act.	25 per cent.
	21	* * * fruit ethers, oils, or essences *Provided*, That no articles of this paragraph shall pay a less rate of duty than 25 per cent ad valorem.	$2 per pound.
	626	Oils: * * * amber, crude and rectified ambergris, anise or anise-seed, * * * cajeput, carraway, cassia, cinnamon, * * * chamomile, * * * civet, * * * fennel, * * * jasmine or jasimine, * * * juniper, * * * mace, * * * rosemary or anthoss, * * * thyme, origanum, red or white, valerian.	Free.
1909	3	* * * distilled oils, essential oils, * * * and all combinations of the foregoing, * * * not specially provided for in this section.	25 per cent.
	21	* * * fruit ethers, oils, or essences *Provided*, That no article of this paragraph shall pay a less rate of duty than 25 per cent ad valorem.	$1 per pound.
	639	Oils: * * * amber, crude and rectified ambergris, anise or anise-seed, * * * cajeput, carraway, cassia, cinnamon, * * * chamomile, * * * civet, * * * fennel, * * * jasmine or jasimine, * * * juniper, * * * mace, * * * rosemary or anthoss, * * * thyme, origanum, red or white, valerian.	Free.
1913	46	Oils, distilled and essential: * * * mace oil * * * amber, ambergris; anise or anise-seed; * * * camomile; carraway; cassia; cinnamon; * * * civet; fennel; jasmine or jasimine; juniper; * * * origanum, red or white; rosemary or or anthoss; * * * thyme; and valerian; all the foregoing oils, and all fruit ethers, oils, and essences, and essential and distilled oils and all combinations of the same, not specially provided for in this section. *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.	6 cents per pound. 20 per cent.

Court and Treasury Decisions.

Oil of cassia, commercially so known, produced by a chemical process from other materials than cassia buds, was held exempt from duty under paragraph 626 of the act of 1897 as oil of cassia. The principle was applied that a tariff provision for an article designating it by a particular name operates upon any goods imported which are commercially known by that name, although such designation had originally a much narrower signification, but owing to changes in

manufacturing processes consequent upon chemical discoveries has come to embrace articles of a different origin or composition from that which was originally known by that particular name. This was expressed in the syllabus in the following words (G. A. 5535, T. D. 24905, of 1904):

When an article is shown to have a certain commercial designation, a tariff provision for merchandise of that name covers it, although said article may be the result of a chemical process in which different materials or ingredients are substituted for the substance from which the article was in former times made, provided, however, that the resultant of the process is a product that differs from the original article in no respect save origin and composition.

Amyl valerianate was classified as a fruit ether under the act of 1890 (G. A. 1939, T. D. 13701, of 1893).

Juniper oil includes not only oil derived from juniper berries but that from juniper wood, and was held exempt from duty as juniper oil rather than as an essential oil under the act of 1894 (G. A. 3822, T. D. 17947, of 1897).

An importation invoiced as essence concrete de jasmine and essence concrete de cassia, semisolid bodies of about the consistence of butter, produced by a secret process, and claiming to represent a high concentration of the odorous principle of jasmine and cassia, was held not to come within the provision for oil of jasmine and oil of cassia, but dutiable as a combination of essential oils under the act of 1890 (G. A. 1414, T. D. 12818, of 1892).

Oenanthic ether, otherwise known as pelargonate of ethyl or pelargonic ether, and classed in the United States Dispensatory as an artificial fruit essence, was classified under paragraph 17, which provided for both fruit ethers and essences rather than under paragraph 60 providing for essential and other oils and chemical compounds (G. A. 3597, T. D. 17406, of 1896).

In classifying oil of mace under the eo nomine provision therefor, rather than as an essential oil under the act of 1890, the Board of General Appraisers declared it "extremely difficult to distinguish oil of mace, which is provided for in the free list, from oil of nutmegs, which is dutiable as an unenumerated essential oil" (G. A. 843, T. D. 11852, of 1891). But in a later case under that act, an importation invoiced as oil of mace and classified by the collector as an essential oil, was declared to be essential oil of nutmeg, and not of mace (G. A. 1854, T. D. 13582, of 1892).

Birch-tar oil, distilled from the wood and used in the dressing of russia leather, was held to come within the provision in paragraph 568 of the free list in the act of 1897 for oils commonly used for stuffing or dressing leather rather than within paragraph 3 of that act providing for distilled oils. (Klipstein *v.* United States, 1 Ct. Cust. Appls., 122, of 1910.)

BIRCH TAR OIL.

General Information.

DESCRIPTION AND USES.

Par. 561, "Oils: Birch tar * * * ." (Free list.)

Birch tar oil or empyreumatic oil of birch is obtained by the destructive distillation of birch wood. It should not be confused with sweet oil of birch which is an essential oil obtained by water distillation of the twigs and leaves of the birch. Birch tar oil consists

chiefly of guaiacol, creosol, and other phenols, while sweet oil of birch is essentially methyl salicylate and is similar to oil of wintergreen in composition.

Birch tar oil is a somewhat viscous brown liquid, having a characteristic odor. It is sometimes adulterated with pine tar and empyreumatic oil of juniper. A rectified birch tar oil is recognized in commerce and is obtained by redistilling the crude oil with steam.

Oil of birch tar is used medicinally as a counterirritant and in pain-relieving applications over sore and stiffened muscles, either alone or diluted with some bland oil. This oil is not of great commercial importance and has no industrial uses.

IMPORTS AND PRODUCTION.

The imports of birch tar oil since first shown (1914) have varied greatly. They have ranged from 12,098 pounds, valued at $571, in 1915 to 110,055 pounds, valued at $22,443, in 1918. In 1914, according to Pickrell,[1] of the 50,533 pounds of *crude* birch tar oil imported, Germany supplied 59.4 per cent and Russia 38.7 per cent.

Although domestic production figures on birch tar oil are not available there should be an adequate supply as a by-product of the wood-distillation industry in this country. Germany and Russia appear from imports to be the principal foreign producers.

TARIFF HISTORY.

Birch tar oil was not mentioned in the tariff laws prior to the act of 1913, when it was put on the free list. There is no special tariff problem connected with birch tar oil. It is of little industrial importance and the entire consumption should be available from domestic sources.

Birch-tar oil (act of 1913)—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				
1914	Free	40,123	$1,898		$0.047	
1915	do	12,098	571		.047	
1916	do	47,757	3,183		.066	
1917	do	24,073	3,717		.154	
1918	do	110,055	22,443		.203	
Calendar year:						
1918	do	103,840	21,195		.204	
1920[1]	do	220	108		.491	

[1] From Jan. 1 to June 30, 1920, inclusive.

Birch-tar oil—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	561	Oils: Birch tar * * *	Free.

[1] Pickrell, Dr. E. R.: Chemicals and Allied substances used in the U. S., Dept. of Commerce, Misc. Series No. 82.

COURT AND TREASURY DECISIONS.

Birch-tar oil before 1913 was classified as a distilled oil (T. D. 9634 of 1889; G. A. 1105, T. D. 12333 of 1891; G. A. 1364, T. D. 12715 of 1892) until the decision of the Court of Customs Appeals in Klipstein *v.* United States, 1 Ct. Cust. Appls. 122 of 1910. The evidence in the court case showed that the birch-tar oil was distilled from the wood and used in dressing Russia leather, and therefore exempt from duty under paragraph 568 of the act of 1897 as oil commonly used in dressing leather and fit only for such uses. A mere possibility of undisclosed use for other purposes was declared not to remove the oil from the operation of paragraph 568. The product of birch tar in issue in T. D. 12333 was known as betulinum oil.

ICHTHYOL AND ICHTHYOL PREPARATIONS.

SUMMARY.

Ichthyol is chemically the ammonium sulphonic derivative of a crude oil obtained by the dry distillation of a fossiliferous rock. The sodium, iron, zinc, and other sulphonic derivatives are known as ichthyol preparations, but the term "ichthyol" has been held to refer only to the ammonium compound. Ichthyol was first patented and introduced to the drug trade by a firm in Hamburg, Germany, who secured their base oil from marine deposits in Seefeld, Tyrol. Oil of similar character has been discovered in the United States and within the current year (1920) large-scale domestic production of ammonium ichthyol sulphonate has been reported. The imports of ichthyol prior to the war amounted to about 50,000 pounds, valued at approximately $75,000, and came principally from Germany. Imports increased to 91,884 pounds in 1917, but the value per pound fell to less than half the prewar figure.

Ichthyol was mentioned specifically on the free list of the acts of 1897, 1909, and 1913. The provision was held to refer, however, only to the ammonium derivative (ammonium ichthyol sulphonate). Preparations other than ichthyol ammonium have been included under the general provision for "all other medicinal preparations," dutiable at 25 per cent ad valorem under the acts of 1897 and 1909, and at 15 per cent ad valorem under the act of 1913.

GENERAL INFORMATION.

PROVISIONS IN THE ACT OF 1913.

"561. (Free list.) Oils: * * * ichthyol, * * *.

"5. * * * all chemical and medicinal compounds, preparations, * * * not specially provided for in this section, 15 per centum ad valorem."

DESCRIPTION AND USES.

Ichthyol is the so-called "ammonium ichthyol sulphonate" or "ammonium sulphoichthyolate," an undefinable chemical combination of sulphonated hydrocarbons obtained by the dry distillation of

a variety of bituminous rock which is found in the Tyrol Mountains of Europe and elsewhere. The word "ichthyol" is derived from Greek and Latin words meaning "fish oil." Although it is technically the crude oil distilled from fossiliferous marine deposits, the term "ichthyol" has become the usual trade designation for "ichthyol ammonium," which is the ammonium preparation of the crude oil. This is largely due to the fact that the ammonium preparation was patented under the name of ichthyol and was so introduced to the trade by the original German manufacturers (Ichthyol-Gesellschaft, Cordes Hermanni & Co., Hamburg) and their American representative (Merck & Co., of New York).

Ichthyol ammonium is the principal ichthyol preparation, but similar compounds are obtained by substituting a sodium, lithium, silver, iron, or zinc salt or albumin or formaldehyde for the ammonium salt. Ichthyol albuminate is known as "ichthalbin," silver sulphoichthyolate as "ichthargan," and ichthyol-formaldehyde as "ichthoform." Other similar preparations are known under various trade names such as "isarol," "sulphothyol," "sulpho-ichthynat," "tumenol," and "hirathiol." "Atreol" is a related product of domestic manufacture.

Ichthyol is described by "New and Non-Official Remedies, 1920," as "a reddish-brown to brownish-black sirupy liquid having a characteristic empyreumatic and burning taste." The ichthyol preparations are used exclusively in medicine, for both internal and external application. They are considered weakly antiseptic and are used externally for skin diseases. Their internal action is in the nature of a gastrointestinal irritant, such as is used in diarrhea and similar diseases.

PRODUCTION AND TRADE.

Germany was formerly the chief source of supply for ichthyol and its preparations, since, as previously noted, ichthyol was first patented in Germany and from there introduced to the American trade. The Hamburg company, which practically controlled the world's trade in this commodity, secured their base oil from the peculiar bituminous shale found in Seefeld, Tyrol. Deposits similar to this have been found in the United States, and their products have recently been placed on the market. The patents for the manufacture of "atreol" from American crude petroleum oil were granted September 16, 1913, and July 2, 1918. (See New and Non-Official Remedies, 1920, p. 319.) A new ammonium sulphoichthyolate was being produced during 1920 by a company which controls a large fossiliferous marine deposit in Texas, from which its base oil is distilled. (See Drug and Chemical Markets, vol. 7, p. 326, 1920.)

Imports.—The imports of ichthyol have varied from 14,379 pounds in 1910, valued at $21,485, to 91,884 pounds, valued at $60,757, in 1917. Prior to the war the bulk of the ichthyol came from Germany and was valued at about $1.50 per pound. Since 1916 the imports have increased in volume, but the price per pound fell to 65 cents during 1917 and 1918 and to 49 cents in 1919. This is explained by the divergent character of the material and the fact that occasional quantities of the crude base oil are probably included in this classification.

Prices.—The Oil, Paint, and Drug Reporter has quoted wholesale prices for ichthyol only since January 1, 1918. At that time it was quoted at the very high figure of $30–$36 per pound. During the latter half of 1918 and during all of 1919 supplies were reported "nominal" (in name only). In January, 1920, ichthyol was quoted at $4.25–$4.50, and this price obtained during the first three-quarters of the year.

TARIFF HISTORY.

Ichthyol was mentioned specifically on the free list of the act of 1897, and this provision has remained unchanged in the acts of 1909 and 1913. The provision has occasioned considerable litigation, however, principally because of the fact that the term "ichthyol" has been taken as the patented name for ammonium ichthyol sulphonate, and in the trade this designation refers to this particular preparation in exclusion of the similar and related preparations such as sodium ichthyol sulphonate. Such preparations are included under the general provision for chemical and medicinal preparations in paragraph 5, dutiable at 15 per cent ad valorem.

TARIFF CONSIDERATIONS.

The classification for ichthyol in paragraph 561 of the free list of the act of 1913 has been held to include only one of the ichthyol preparations, although a number of others are articles of commerce. There is no reason to believe that Congress originally intended that one compound of ichthyol should be admitted free while the others should be declared dutiable. Consideration should be given, therefore, to the advisability of including in one provision (either on the free or dutiable list) all preparations of ichthyol.

The commercial production of ichthyol and similar preparations in the United States is a very recent development and complete information in regard to the new industry is not available at this time.

Ichthyol—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	74,217	$113,494		$1.53	
1910	do	14,379	21,485		1.49	
1911	do	39,745	59,504		1.49	
1912	do	49,872	72,184		1.45	
1913	do	44,347	61,796		1.39	
1914	do	66,957	92,485		1.38	
1915	do	51,847	70,664		1.36	
1916	do	69,227	59,470		.85	
1917	do	91,884	60,757		.66	
1918	do	65,962	43,541		.65	
1919	do	19,623	9,830		.49	
1920 [1]	do	69,294	53,698		.77	

[1] Six months.

Ichthyol—Prices, wholesale, New York, spot, in dollars per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1918[1]		1919		1920	
	Low.	High.	Low.	High.	Low.	High.
January	$30.00	$36.00	(2)	(2)	$4.25	$4.50
April	30.00	36.00	(2)	(2)	4.25	4.50
July	(2)	(2)	(2)	(2)	4.25	4.50
October	(2)	(2)	(2)	(2)	.....	.....

[1] Prices were not quoted prior to 1918. [2] Nominal.

Ichthyol—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	626	Oils: * * * ichthyol, * * *.....	Free.
1909	639	.....do.....	Do.
1913	561	.....do.....	Do.

Court and Treasury Decisions.

DECISIONS UNDER THE ACT OF 1897.

Ichthyol was held to be the commercial or trade name for ammonium ichthyol-sulfonate, and a chemical salt. (G. A. 5703, T. D. 25376.)

Ichtosulfol, although resembling ichthyol in composition and appearances, was held not the ichthyol of commerce nor chemically identical with ichthyol and dutiable as a nonalcoholic medicinal preparation under paragraph 68. (Abstract 20719, T. D. 29597.) Ichthyol sodium was likewise classified. (Abstract 20720, T. D. 29597.) This decision was affirmed by the circuit court for the southern district of New York. In the absence of words indicating an intention to include the different ichthyol products paragraph 626 was declared not to include ichthyol sodium. (Merck *v.* United States, 177 Fed., 482; T. D. 30315.)

Isarol, known as ichthyol ammonium, ammonium ichthyol sulphonate, and ammonium sulphoichthyolate, a compound obtained by the treatment of crude ichthyol oil with sulphuric acid and neutralized by ammonium carbonate, was held exempt from duty under paragraph 626 as ichthyol oil. (Cassett *v.* United States, 2 Ct. Cust. Appls., 465.)

DECISIONS UNDER THE ACTS OF 1909 AND 1913.

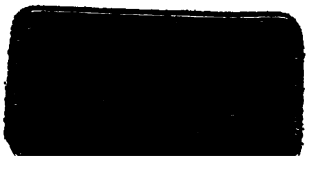
Lithyol, classified as a medicinal preparation under paragraph 65 of the act of 1909, was held free of duty as ichthyol oil under paragraph 639. (Abstract 29519, T. D. 32767.)

Sulphoichthynat was likewise classified. (Abstract 30570, T. D. 32960.)

Sulfothyol, essentially ammonium sulfoichthyolate, was likewise classified under paragraph 561 of the act of 1913. (T. D. 36028.)

Ichtosan, imported in capsules, pills, tablets, lozenges, or similar forms, being a medicinal substance, was held dutiable under the latter part of paragraph 17 of the act of 1913. But ichtosan put up in packages of less than 2½ pounds gross weight, assessed with duty under the first part of that paragraph, was held exempt from duty as ichthyol oil under paragraph 561. (Abstract 40442.)

○



UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 30 and 31 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

TANNING MATERIALS AND NATURAL DYES

(Includes all tanning materials and natural dyes provided for in the act of 1913, in paragraphs 30, 31, 399, 455, 469, 475, 492, 536, 538, 553, 564, 618, 624, 630, 634, and 639)

REVISED EDITION

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U.S. Tariff Com.
6-4-28

PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus by use of this "Introduction and Index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Warren N. Watson, of the chemical division of the commission's staff, and of others.

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TANNING MATERIALS AND NATURAL DYES.

Introduction.

The vegetable tanning materials and natural dyes are grouped under one heading, as their source, preparation, uses and chemical nature indicate a close relationship. In certain cases it is difficult to determine whether a given product has greater use as a tanning agent or as a natural dye.

The American tanneries, previous to 1900, obtained practically their entire supply of tanning materials from domestic sources—nearly all hemlock and oak. As the virgin forests of these products were becoming exhausted, chestnut extract, made from chestnut wood of abundant growth in the Appalachian region, was accepted and the production of this extract has since become highly developed in that area.

Since 1900 a large import trade has developed in foreign tanning materials from many parts of the world to replace the insufficient supply of oak and hemlock and to obtain cheaper tanning agents. These include woods, leaves, barks, fruits, nuts, pods, and other vegetable materials, with the extracts made by hot-water treatment of these products, with subsequent evaporation.

The important imported tanning materials include quebracho (logs and extracts), mangrove (bark and extracts), myrobalans (fruit and extracts), sumac (leaf and extracts), divi-divi (pods and extracts), valonia (cups, beards, and extracts), wattle (bark and extracts), and Gambier.

Important domestic tanning materials include chestnut-wood extract, hemlock (bark and extract), oak (bark and extract), sumac (leaf and extract). Chestnut-wood extract is the most important domestic tanning agent and is available in quantities in excess of domestic needs. The chestnut blight at present threatens the entire stand of chestnut, which will have a tendency to accelerate the rate of cutting. The annual cut of hemlock and oak barks is decreasing. At the present rate of consumption, it is estimated that the supply of these barks will be exhausted in about 40 years. This does not include the Western hemlock of Oregon and Washington, which offers a large future supply of bark, utilized at present only to a small extent.

The tariff rates on tanning materials not only affect the domestic producer of crude tanning materials, but also manufacturers of extracts, tanners, and indirectly users of leather.

In connection with the tariff, the crude tanning materials should be considered from the viewpoint of competition with domestic materials, and also from the standpoint of necessary supplies for domestic extract manufacture. Domestic production of extracts from imported crude materials is favored by a duty on extracts with either a low duty, or no duty, on the crude materials.

The natural dyes previous to the introduction of coal-tar dyes served as a basis of dyeing from ancient times. Although synthetic dyes have largely displaced the natural dyes, for certain uses the natural dyes are in demand, chiefly in the textile and leather trades. They are prepared from woods, barks, roots, plants, leaves, flowers, berries, and insects.

Certain natural dyes, extracts of logwood, fustic and redwood, are made in this country from woods imported from the West Indies, Central and South America. The manufacture of dyewood extracts is a highly developed domestic industry. In addition, a variety of dyes prepared from foreign vegetable sources are imported into the United States ready for use. These include, cutch, archil, and cudbear, natural indigo, saffron, safflower, cochineal, tumeric, annatto, litmus, chlorophyll extract, madder, and Persian berries.

Quercitron and osage orange (the latter of recent development) are the important domestic natural dyes. Imported fustic is competitive to these products for certain uses. Domestic sumac is considered under tanning materials. In the case of the dyewoods, a duty on the extracts and a low rate of duty or no duty on the crude material favors the domestic production of extracts in the United States.

This report contains tariff information on the following:

I. Tanning materials:
- Chestnut extract.
- Divi-divi (pods and extract).
- Gambier.
- Hemlock (bark and extract).
- Mangrove (bark and extract).
- Myrobalans (fruit and extract).
- Oak (bark and extract).
- Quebracho (logs and extract).
- Sumac (leaf and extract).
- Valonia (cups, beards, and extract).

II. Natural dyes:
- Annatto.
- Archil and cudbear.
- Chlorophyll extract.
- Cochineal.
- Cutch.
- Fustic.
- Indigo.
- Litmus.
- Logwood.
- Madder.
- Osage orange.
- Persian berries.
- Quercitron and Flavine.
- "Red woods" (Brazil, Cam, Bar, and Sander's wood).
- Saffron, or ' ffron valencia and safflower or American saffron.
- Turmeric.

TANNING MATERIALS.

CHESTNUT EXTRACT.

SUMMARY.

Chestnut extract is the most important domestic tanning material in value and quantity consumed, and its manufacture constitutes one of the large industries in the southern Appalachians. The extract is used in tanning sole and other heavy leathers. It is prepared from chestnut wood by hot water extraction, the resulting liquid being evaporated to a thick liquid or solid.

The supply of wood is obtained from the Appalachian chestnut belt. Thirty-four extract factories are located in the following States: Tennessee, North Carolina, Kentucky, West Virginia, Pennsylvania. Several of the large companies have from $1,000,000 to $2,500,000 invested in the extract plant and supply of wood on hand. The chestnut area would probably last, at the present rate of consumption, for 200 years. The bark disease, however, threatens the entire stand of chestnut growth in the United States; within 15 years the disease can be expected to cover the chestnut area.

Although the dead trees are used for extract manufacture and the large amount of dead growth has given a temporary increase in wood supply which must be utilized to avoid loss, there is practically no new growth in a region infected with this disease, so the future supply is problematical.

During the war domestic extract was exported to England due to the failure of the French supply. Domestic chestnut extract has been free from competition of foreign chestnut extract, as only small amounts of chestnut extract have been imported into the United States. The French extract offers competition to domestic extract only in the European markets. Unlimited importation of the extracts quebracho and mangrove would tend to curtail the domestic production of chestnut extract.

GENERAL INFORMATION.

Act of 1913, paragraph 624: Tanning material * * * extract of the oak and chestnut and other barks and woods other than dyewood such as are commonly used for tanning not s. p. f. in this section; * * * whether or not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process; and articles in a crude state used in dyeing or tanning; all the foregoing not containing alcohol and not s. p. f. in this section, *free*.

DESCRIPTION.

Chestnut extract is a valuable tannage made from the wood of the chestnut tree (*Castanea vesca*). It is the most important domestic tanning material in value and quantity produced. The world's production of chestnut is confined to three areas: (1) Eastern United States, (2) southern France and Corsica, (3) in that section

of the Austrian Empire known as Slavonia. The chestnut belt in the United States is in the Appalachian Mountain region, running from New York to the northern part of Georgia. These forests cover parts of New York, Pennsylvania, West Virginia, Virginia, Kentucky, North Carolina, South Carolina, and Georgia.

The tree is of rapid growth, reaching a height of 60 to 80 feet. The old growth is in good demand for lumber. It has, however, a tendency to become wormy.

Extracts.—The domestic seasoned chestnut wood contains 5 to 11 per cent tannin: the average is reported to be 6.6 per cent. The French seasoned wood has the same tannin content, the feshly cut contains 4 per cent tannin and 75 per cent water, and less iron than the domestic wood. The Corsica seasoned wood runs as high as 12 to 13 per cent tannin. The French chestnut yields a lighter colored extract than the American. An approximate rule of the tanners places a barrel of chestnut liquid extract (500 pounds, 25 per cent tannin) equivalent to 1 ton or 1 cord of oak or hemlock bark.

Chestnut extract is identical or nearly identical with gallo tannin and contains also a small amount of catechol tannin, as the red coloring matter resembles in character a phlobaphene. The extract contains in addition large amounts of nontannins, which vary with the source of the wood and method of manufacture. These consist of sugars, resins, inorganic salts, etc., and are of great importance as they yield on fermentation in the tanning vats acids that produce "plumping."

The extracts are marketed as "clarified," "unclarified," and "blood decolorized" extract. These have 25 or 35 per cent tannin content. The solid chestnut extract has 60 to 70 per cent tannin content. The "decolorized extract" is made by addition or treatment with one of the following agents: Blood, sulphate of aluminum and sodium bisulphite, rosin soap with barium salts, osage orange extract, and commercial decolorizers. The French blood decolorized extract has a slightly lower color content than the American extract, and for this reason has been competitive with American extract in the English market. The liquid extracts are shipped in iron tank cars (internally painted with red lead to prevent action on the iron) and in wooden barrels. The solid extract is shipped in paper-lined burlap bags containing from 100 to 150 pounds each. The liquid extracts are thick brown liquids with the odor of burnt sugar; on dilution they become turbid due to the brown phlobaphenes.

Uses.—Chestnut extract is the most important tanning agent used in the United States. It is used chiefly on sole leather, harness, and belting. It also serves as a weighting agent and a mordant in the dyeing of blacks on silk. In tanning, chestnut extract is used in combination with other tanning materials. Chestnut imparts firmness and solidity to leather and gives efficient, rapid, and thorough penetration. The souring qualities are between those of oak and of hemlock, no other extract possesses this feature. It is consequently used in combination with a nonsouring tannage, as quebracho. This acidity neutralizes the lime left in the leather after the liming process "plumps" the leather, thereby assisting in the ready uniform penetration of the tannin.

DOMESTIC PRODUCTION.

Supply of wood.—A conservative estimate of the chestnut area available to the extract industry is approximately 250,000 square miles or 160,000,000 acres. Allowing only 1½ to 2 cords per acre, this would last at present rate of consumption about 100 years. Unfortunately, the bark disease which is spreading rapidly at present threatens the entire stand in America.

Destruction of forests by bark disease.—According to information supplied by the Office of Forest Pathology, Department of Agriculture, the chestnut bark disease, a fungus (*Diaporthe parasitica*) importation from Japan and China was first recognized as a serious disease around New York City in 1904. Since then the disease has spread steadily from New York as a general center, rapidly killing the chestnut forests.

The disease has spread over most of Pennsylvania. The two extract plants in that State have been using wood killed by the disease for a number of years. In West Virginia the disease is present in parts of the territory from which the extract plant at Elkins draws its wood supply. In Virginia the chestnut growth east of the Blue Ridge Mountains from Maryland south to the North Carolina line is infected. Nine extract plants in that State now have the disease present in the territory from which they secure their supply of wood. Within 15 years the disease can be expected to extend over most of the chestnut region of North Carolina and Tennessee, which region includes nearly all of the remaining extract plants.

There is practically no new growth of chestnut in a region heavily infected with this disease. Seedlings and sprouts are killed before they attain sufficient size to be marketed as extract wood. In general, the presence of this disease produces an increased supply of extract wood on the market for a number of years due to the death of the trees, but the stand of chestnut available for future use of the extract plants is greatly diminished. These plants can use dead standing chestnut for many years after the trees have been killed. The stand of dead timber has resulted in the increased use of chestnut timber for telegraph poles, ties, staves, and lumber finish.

Equipment and method of production.—The chestnut extract plant is located near the source of wood supply; the site usually chosen has 25 years' wood supply, based on full capacity, an abundance of soft water, sufficient labor and coal at reasonable cost, good railroad facilities, and convenient to a machine shop and foundry.

With respect to the size of the factory, there are two points at which the maximum economy of operation is obtained. The small unit of about 70 barrels per day production, and the next unit with a production of 150 barrels or over per day.

The small unit has lower fixed charges, smaller capital invested, and lower cost of operation in proportion to output. The wood can be purchased direct from farmers or lumbermen, saving large capital investment in timberland and lumbering operations and railroads. Contracts on 1 to 100 cars are made with the farmers. These are placed more as a matter of form as a guarantee to the farmer for a market. A farmer with a 10-car contract will ship 2 cars, or possibly 20, and if another firm makes a higher offer he may sell his entire cut

to the latter firm. A single installation of machinery is compact and easily kept in repair. On the other hand, the small plant, unless kept in full operation, is not able to compete with larger plants under adverse business conditions.

For a plant next in size, the minimum cost of operation per barrel is reached at about 175 barrels per day capacity. The investment in building, equipment, and timberland is increased in proportion to output. For a large unit, 200 to 300 barrels per day is the capacity for best economy of operation. There are over 9 plants in the United States of 200 or more barrels per day production. Most of the factories are of wood construction; several of the newer plants, however, are of brick or concrete to reduce fire hazard.

The successful operation of the extract factory depends almost entirely on mechanical efficiency, which insures a uniform and continuous delivery of raw materials. The steam plant has an installation of 7 to 10 horsepower per barrel per day of output. One of the large manufacturers, however, uses electrical power.

The first operation of chipping the wood is usually carried out with the "wood hog." This is a heavy high-speed machine with chipping knives, which can cut as high as 5 cords of wood per hour. The chips are then usually passed through a shredder to complete the disintegration. This machine consists of several score of loose heavy hammers, swinging from a common central disk revolved at a very high speed. About 5 horsepower per cord are required for the wood disintegration. The disk type of cutter is satisfactory on green wood, and gives a chip which after extraction is satisfactory for the manufacture of wood pulp. The chips from the hog and shredder are not satisfactory for this purpose. From the grinding room the wood is passed through a screen containing one-quarter-inch perforation and transferred to the leach house. The vats are usually of cyprus; for large vats, however, concrete has been found cheaper. New installations consist of copper autoclaves, each holding a cord and a half of wood. The extraction is carried out under a pressure. Extraction is carried out by three methods—diffusion, decoction, and percolation.

The *diffusion method* extracts the chips by immersion in hot water contained in a series of large tanks. By means of a steam jet or compressed air the liquor is kept in continuous circulation from one tank to another. The diffusion method involves heating large volumes of water, requires several extractors, and from 2½ to 4 days from the time the extractor is filled until it is emptied. Furthermore, the exposure to air is claimed by some to injure the quality of the extract.

By *decoction* the chips are immersed in water, boiled, and the resulting solution withdrawn. Several water treatments are given, using weaker solutions from another extractor until the solution becomes saturated. A 10-leach battery can be turned over in 24 hours. A smaller volume of water is required by this process (about 300 gallons per ton of wood), which results in a great economy in evaporation. For extraction by decoction it is not necessary that the chips be so small or uniform in size as for the diffusion or percolation methods.

Percolation requires a smaller amount of water, but careful supervision. The wood is first steamed and hot water sprayed over the

chips until extraction is complete. Each container is a separate unit and the extraction is thorough.

Evaporation.—The leach liquors after passing through strainers may be given a chemical treatment and are ready for concentration. Efficient evaporation is fundamental to the success of the extract plant. Each cord of wood leached necessitates the evaporation of about 1,400 gallons of water; for a plant producing 250 barrels of extract per day approximately 225,000 gallons of water must be evaporated. In early practice single-effect evaporators were used; at present triple-effect evaporators of the vertical tube type are commonly used. Several plants have tried the film evaporators.

After evaporation the extract is pumped to storage tanks and allowed to cool and settle. The solid extracts are produced in vacuum rotary dryers or by drying atomized extract in a current of hot air.

Costs and yield.[1]—The cost of erecting a modern extract plant equipped with autoclaves with an output of 200 to 250 barrels per day is approximately $2,000 per barrel per day output. In case the buildings are of temporary character the investment per barrel per day output is $1,500. Investment for raw material is about $500 per barrel, tank cars $25 per barrel, and book accounts $25 a barrel. As most of the extract is sold on long-term contracts, a large supply of wood must be available to guarantee deliveries and to maintain the quality of extract. Operating expenses, including overhead but not interest, varies from $2.75 to $3 per cord. In 1913 the average price received was about 4.6 cents per unit of tannin. The production yield was from $8 to $9.50 per cord, with a cost of $7.57 to $8.04. At present the margin of profit is larger and the industry is financially in a better condition.

The yield of a cord of 160 cubic feet under best conditions may reach 800 pounds of extract of 25 per cent tannin content; this is equivalent to 1⅔ barrels, each barrel containing 500 pounds. Under present practice the yield is 600 to 700 pounds per cord.

Organization.—There are about 34 chestnut-extract plants. These fall into three classes—the "selling producers," those who manufacture extract for sale only; the "consuming producers," those who manufacture extract for their own consumption; and the "selling and consuming producers," who manufacture extract for both their own consumption and for sale. These factories are independent units, requiring several hundred thousand dollars' investment in the smaller-sized units. One of the large companies has $750,000 invested in its plant. The stock of wood on hand—60,000 cords, a six months' supply—necessary to insure uniformity of extracts represents $400,000 capital. The water flumes for wood transport cost $600 to $2,000 per mile, and the narrow-gauge railroads cost $2,000 to $5,000 per mile. For the successful operation of the plant technical and experienced control are necessary. In case the blight did not threaten the industry, the future developments would involve greater capital investment, with longer railroads, paper mills, and reforestation.

[1] By-products of the Lumber Industry, Department of Commerce. Special Agents Series, No. 110. H. K. Benson, "The manufacture of chestnut extract in the United States." G. H. Kerr of American Leather Chemists' Association, vol. 5, 1910, p. 485.

Geographical distribution.—The chestnut-extract plants are situated in or near the Appalachian chestnut belt, in the following States: Tennessee, North Carolina, Kentucky, West Virginia, Virginia, and Pennsylvania.

History.—Until recently the American tanners depended on the virgin forests for the supply of hemlock and oak, the only tanning materials at one time in use. Increased production of leather required more tanning materials. The hemlock-bark output has decreased one-third in the last 10 years, and oak-bark production has also decreased. The search for tanning materials has consequently extended over the entire world. In France, Michel, of Lyons, discovered tannin in chestnut wood. The manufacture of concentrated tanning extracts originated in France in the early seventies and was made from chestnut wood. The most important development in the United States was the production of chestnut extract after demonstration that this extract was a satisfactory tannage. Its use increased with great rapidity. The industry is practically a development of the last 15 years, growing until the yearly production amounts to the equivalent of about 600,000,000 pounds chestnut liquid extract, 25 per cent tannin.

During the war the United States was fortunate in having chestnut extract available as a tannage for the increased production of leather. In addition to supplying the domestic demand the United States exported chestnut extract to Great Britain, and at present an increased export trade is being developed.

Domestic production and consumption.—In the last census of manufactures, 1914, the domestic production of oak and chestnut extracts was 328,197,524 pounds, valued at $4,130,042. No exports are recorded for 1914. In 1900, 28,983,036 pounds of oak and chestnut extract were manufactured, valued at $529,670. Of the total tanning materials consumed in 1905, chestnut constitutes 17 per cent; this gradually increased to 48 per cent in 1909.[2] Reported estimates of the present production indicate a yearly output of about 600,000,000 pounds. Information gathered by the War Trade Board indicates that in 1917 the United States consumed 18,308,265 pounds of liquid extract and 1,858,580 pounds of solid extract.

Domestic exports.—Previous to the war the United States did not export large amounts of chestnut wood extract. One company exported considerable decolorized extracts to England. Due to the failure of the supply from the Continent during the war, England was obliged to import from the United States for her tanneries. Since 1915 our exports have been confined almost entirely to Great Britain. Great Britain has established a world reputation in the production of sole leather and the British tanneries have always been the largest consumers of chestnut extract, which they blend with myrobalan or valonia. In 1918 approximately 1,200 tons a month of chestnut extract were exported to England. The American tanning extract manufacturers formed in 1919 an export corporation. It was reported in 1919 the excess production for export over domestic production was about 150,000,000 pounds of 25 per cent tannin extract or its equivalent in solid extract. As the domestic production capacity far exceeds the domestic consumption and the increas-

[2] The Eastern Hemlock, U. S. Department of Agriculture, No. 152, p. 13.

ing amount of deadwood which must be utilized to avoid loss will further increase the amount of extract produced, the development of the export trade is of great importance to the chestnut extract industry.

FOREIGN PRODUCTION.

France is the largest foreign producer of extract, using over 600,000 tons of chestnut wood per year for the manufacture of extract, valued at nearly $8,000,000 per year.

In the period 1912–1914 the average yearly export from France of chestnut extract and other dry tannin vegetable extracts was 212,490,665 pounds, valued at $3,165,558.

IMPORTS.

The imports for consumption have been negligible, excepting in 1914, when 256,078 pounds were imported valued at $4,234. In 1913 and 1917 imports valued at $21 and $15, respectively, were made.

PRICES.

In 1912–13, and until the third quarter of 1914, the price of ordinary chestnut extract (25 per cent tannin) was 3¾–4 cents per pound. In 1917 the price was 3–3½ cents per pound. From this figure, after a slight drop, it rose to 3–3¾ cents per pound. The clarified chestnut extract (25 per cent tannin) for 1917 was 3¼–3¾ cents per pound. This figure held until the first quarter of 1918, dropping to 3⅛–4¼ cents per pound, returning in the last quarter of 1919 to the former price, 3¼–3½ cents per pound. Manufacturers report that the preceding market quotations are considerably in excess of the actual price received.

One large firm reports the following contract prices on chestnut extract 25 per cent tannin in tank cars f. o. b.:

	Per 100 pounds.		Per 100 pounds.
1912	$1.20–$1.25	1916	$2.25 –$2.50
1913	1.25– 1.30	1917	2.12½– 2.50
1914	1.15– 1.25	1918	2.12½– 3.25
1915	1.40– 1.75	1919	– 3.25

TARIFF HISTORY.

Act of 1913, paragraph 624: "Tanning material * * * extracts of oak and chestnut and other barks and woods other than dyewoods such as are commonly used for tanning not specially provided for in this section," free.

Act of 1909, paragraph 22: "* * * extracts * * * of woods other than dyewoods, not specially provided for in this section, five-eighths of one cent per pound.

Act of 1897, paragraph 22: "* * * extracts * * * of woods other than dyewoods, not specially provided for in this act, five-eighths of one cent per pound.

COMPETITIVE CONDITIONS.

The chestnut extract industry has not been subjected to competition by importations of that article. Unlimited importation of quebracho and mangrove, although tannages of different characteristics, will tend to force the domestic chestnut extract manufacturer to curtail production. These products can offer serious competition to chestnut extract. France is the large European producer of chestnut extract. In 1910 France had 30 chestnut extract factories, producing 40,000,000 francs worth of extract annually. The consumption of the extract industry threatens the stand of chestnut in France. France exports chestnut extract to England and other countries of Europe. The export trade of our domestic extract is competitive with the French product in Europe. The French extract has a slightly lower color content; while this has little recognized superiority in the United States, the European tanner is accustomed to and prefers the lighter colored product.

Oak and chestnut extracts, for tanning—Production in United States—"Official source."

[From Census of Manufactures, Table 101.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1899	28,983,036	$529,670	1909	266,529,514	$4,321,687
1904	156,520,123	2,411,184	1914	328,197,524	4,130,042

Chestnut and other tanning extracts—Exports from France (fiscal years).

Exported to—	1910		1911 [1]		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Great Britain	353,663	.....	.....	.....	418,210	.....
Germany	134,905	.....	.....	.....	162,076	.....
Belgium	146,157	.....	.....	.....	141,993	.....
Italy	11,886	.....	.....	.....	17,363	.....
Roumania	6,179	.....	.....	.....	11,761	.....
Denmark	16,652	.....	.....	.....	23,525	.....
Russia	19,335	.....	.....	.....	13,236	.....
All other	58,569	.....	.....	.....	99,753	.....
Total	747,346	$2,596,280	.....	.....	887,917	$3,255,992

Exported to—	1913		1914	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Great Britain	440,345	.....	324,695	.....
Germany	171,952	.....	95,015	.....
Belgium	136,128	.....	76,478	.....
Italy	26,326	.....	14,741	.....
Roumania	20,063	.....	12,541	.....
Denmark	19,610	.....	16,941	.....
Russia	18,719	.....	12,229	.....
All other	104,143	.....	79,385	.....
Total	937,259	$3,475,710	632,025	$6,099,041

[1] Figures not available.

Chestnut and other tanning extracts—Exports from France (fiscal years)—Continued.

Imported from—	1915		1916	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Great Britain	144,700		117,992	
Switzerland	5,715			
Portugal	732		893	
Egypt	919		1,180	
Japan			101	
Italy	5,582			
All other	16,993		3,328	
Total	174,641	$2,022,343	123,594	$1,431,219

Chestnut extract and other dry tannin vegetable extracts—Exports from France.

	Rate of duty.	Quantity.	Value.	Price per pound.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*		*Franc at par*		
1912		230,777,528	$3,262,858	0.0141		
1913		243,659,888	3,807,504	.0156		
1914		163,034,579	2,426,396	.0149		
1916		34,353,180	1,533,771	.0446		
1917		48,383,254	2,160,249	.0446		
1918		39,455,065	1,761,511	.0446		

Chestnut extract for tanning, not containing alcohol—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				
1910						
1911						
1912						
1913						
1914						
1914	Free	256,078	$4,234		$0.017	
1915						
1916	Free	458	21		.045	
1917	Free	120	15		.125	
1918						
1920						

Extracts for tanning, not containing alcohol—Woods, other than dyewoods, n. e. s.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				
1909	½ cent per pound	5,006	$1,400	$31	$0.280	$2.24
1910	do	192,207	4,794	1,201	.025	25.06
1911	do	121,777	3,723	761	.031	20.44
1912	do	82,226	1,326	513	.016	38.76
1913	do	8,045	162	50	.020	31.04
1914 [1]	do	10,256	254	64	.025	25.24
1914	Free	2,048,580	57,570		.028	
1915	do	1,039,919	31,135		.030	
1917	do	515,271	33,291		.065	
1918	do	1,065,752	57,762		.054	
Calendar year—						
1918	do	1,668,942	67,890		.0406	
1919	do	2,145,120	122,204		.057	
1920 [2]	do	690	58		.0840	

[1] Old law (1914) read "Extracts for tanning." [2] 6 months ending July 1, 1920.

Extracts for tanning, not containing alcohol—Other n. s. p. f.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				*Per cent.*
1914	15 per cent [1]	761,735	$21,491	$3,223.00	$0.028	15.00
1915	do	936,737	30,064	4,509.00	.032	15.00
1916	do	531	117	17.00	.220	15.00
1917 [2]						
1918	15 per cent	224,224	7,423	1,113.45	.033	15.00
Calendar year—						
1918	do	224,224	7,423	1,113.45	.033	15.00
1919	do	26,354	2,372	355.80	.090	15.00
1920 [3]	do	134,400	12,575	1,886.25	.093	15.00

[1] Not separately stated prior to 1914. [2] Not listed. [3] 6 months ending June 30, 1920.

Chestnut extract (France)—Imports for consumption—Revenue.

[From Chimie et Industrie.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				
1912		2,854,075	$42,460			
1913		2,577,398	76,620			
1914		2,017,429	60,020			
1916		448,857	20,070			
1917		96,341	4,250			
1918		227,956	10,230			

Chestnut, ordinary. 25 per cent tannin—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	3½–4	[1] 3½–4	[1] 3½–4	5–5½	5 –5½	3–3½	3 –3½	2⅞–3½	[2]
April	[1] 3½–4	[1] 3½–4	3½–4	5–5½	4½–4¾	[1] 3–3½	3 –3½	3 –3½	[2]
July	[1] 3½–4	[1] 3½–4	3½–4	6–7	4 –5	[3] 3–3½	2½–4¼	3 –3½	[2]
October	[1] 3½–4	[1] 3½–4	5 –5½	6–7	5 –6	3–3½	2½–3¾	[2]	[2]

[1] Listed as "Chestnut" only. [2] Not quoted [3] Tanks.

Chestnut, clarified, 25 per cent tannin—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January				5¼–5¾	5¼–5¾	3¼–3¾	3¼–3½	3½–4¼	[1] 3½–3½
April								3½–4¼	[1] 3½–3½
July								3½–4¼	[1] 3½–3½
October							3½–4¼	[1] 3¼–3½	[1] 3¼–3½

[1] Tanks.

Chestnut, clarified, 25 per cent tannin—Prices per pound, in barrels, wholesale, New York

[From Oil, Paint, and Drug Reporter.]

Month.	1919	1920	Month.	1919	1920
January		3½–4	July		3½–4
April		3½–4	October	3½–4	3½–4

Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	22	* * * Extracts of sumac, and of woods other than dyewoods, n. s. p. f. in this act.	⅛ cent per pound.
1909	22	* * * Extracts of sumac, and of woods other than dyewoods, n. s. p. f. in this section.	Do.
1913	624	Tanning material * * * extracts of oak and chestnut and other barks and woods other than dyewoods such as are commonly used for tanning, n. s. p. f. in this section.	Free.

DIVI-DIVI AND DIVI-DIVI EXTRACT.

GENERAL INFORMATION.

Act of 1913, paragraph 475: Divi-divi, free.

Divi-divi extract not specifically mentioned, T. D. 21261, paragraph 30, dutiable at ⅛ cent per pound.

Description.—Divi-divi, a valuable tanning agent, consists of the dried beanlike pods of the Caesalpinia coriaria, a tree of 20 to 30 feet in height growing in the West Indies, Central and South America, particularly in the neighborhood of Maracaibo and the coasts of Curacao and Cartagena. Geographically, divi-divi is the most accessible foreign tanning material to the United States.

The divi-divi pods are 2 to 3 inches long, rather thin, and after drying frequently resemble in shape the letter "S." They are of a red to black brown color and have a high tannin content (40 to 45 per cent), consisting of ellagitannic acid and probably also a gallotannin. The seeds do not contain tannin. The best grade of pods are thick and fleshy and of a light color. Dark colored pods with black patches have less value for tanning and were damaged by gathering in a wet condition or by exposure to dampness.

Divi-divi extract is marketed as a 42° liquid of approximately 25 per cent tannin content.

Uses.—Divi-divi is used almost entirely as a tanning agent. It has a limited application in dyeing blacks on silk. It is not used as a self tannage, but in conjunction with other tanning materials, such as quebracho, which do not develop acidity.

It is usually present in the tanning liquors to the extent of less than 10 per cent. Divi-divi readily develops acidity which causes the "plumping" of the leather. This tanning agent is frequently blended with myrobalans, wattle, and mangrove barks. It serves also as a partial substitute for gambier in dressing leather.

Domestic production.—Divi-divi pods are not grown in the United States, our entire supply being imported from Central and South America and the West Indies.

Divi-divi extract is made in the United States by one domestic extract manufacturer. The equipment and method of preparation is similar to that used in the production of sumac extract. The pods are treated with hot water and the resulting liquor evaporated under reduced pressure to a liquid of 42° density, containing approximately 25 per cent tannin.

It is reported that over 90 per cent of the imported divi-divi pods are leached by the tanner.

Foreign production.—Import data on divi-divi extract is not available. Reports indicate that if divi-divi extract is imported at all the quantity imported in the last few years has been small.

Imports.—In the prewar period, 1908–1913, our annual import of divi-divi varied from a minimum of 134,133 pounds valued at $2,398 in 1908 to a maximum of 654,404 pounds valued at $13,130 in 1910. After a very small import in 1914, the import of 1915 increased to 4,513,219 pounds, valued at $71,367, and in 1916 reached the maximum of 16,467,455 pounds valued at $310,572. The figures for 1917 and 1918 showed a slight decrease compared with those of 1916. Imports of divi-divi extract are not available. It is reported that imports of this extract, if any has been imported at all, have been small during the last few years.

Prices.—In the period from January, 1912, to July, 1914, divi-divi is quoted at $45 to $55 per ton, increasing to $55 to $75 per ton in the latter part of 1914 and receding to $35 to $40 per ton in July, 1915. In January, 1916, it is quoted at $50 to $55 per ton, gradually increasing (with the exception of a drop in the latter part of 1916) to $73 to $75 per ton in July, 1918, reaching a maximum of $85 to $87 per ton in 1920. The July, 1920, quotation was $65 to $70.

Tariff history.—Divi-divi is mentioned on the free list as far back as 1883. The extract of divi-divi is dutiable at three-eighths cent per pound. (T. D. 21261, p. 30.)

COMPETITIVE CONDITIONS.

Prior to the war nearly all of the divi-divi was shipped to Europe, Germany being the chief consumer. Before the war the United States bought small quantities of divi-divi in competition with the German buyers. During the war the scarcity of tonnage and exorbitant freights prevented the importation in significant amounts of Turkish valonia, African mangrove, India myrobalans wattle bark, and East Indies mangrove extract. Quebracho alone was imported in large amounts, for which shipping was allocated. Divi-divi was the most available foreign tanning material and required a comparatively short haul. Its acid-forming properties made it a special value in combination with the nonsouring tannins, as quebracho. The United States imported nearly the entire production of divi-divi during the war. It is reported that European buyers, namely, Holland, England, France, and Sweden are again active in the purchasing market for divi-divi. Competition offered by the Holland buyers is most keen, as they have trading companies at Curacao and frequent low-priced steamer and sailing vessel accommodations to Europe.

The ocean freight rate from South America to the United States and to Europe is one of the determining factors in the availability of divi-divi to the domestic tanner. The consumption of this tanning material depends on its price compared with that of other tanning materials.

Divi-divi extract is made in the United States by one extract manufacturer. Active competition with the domestic made extract by imported extract of foreign manufacture is not reported.

TARIFF CONSIDERATIONS.

Divi-divi is not grown in the United States. This tanning material has no exact equivalent of domestic origin and is not directly competitive with our domestic tanning agents. The divi-divi pods do not present a tariff problem. The bulk of divi-divi pods are directly leached by the tanner. The imports of divi-divi extract are reported to be small and have not offered serious competition with extract of domestic manufacture.

Divi-divi—Imports for consumption—Revenue.

	Rates of duty.	Quantity.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				
1908	Free	134,133	$2,398		$0.018	
1909	do	186,943	3,166		.017	
1910	do	654,404	13,130		.020	
1911	do	496,130	8,169		.016	
1912	do	221,659	2,807		.013	
1913	do	314,491	4,143		.013	
1914	do	29,032	461		.016	
1915	do	4,513,219	71,367		.016	
1916	do	16,467,455	310,572		.019	
1917	do	15,969,144	293,191		.018	
1918	do	15,739,331	274,891		.017	
Calendar year:						
1918	do	22,092,927	428,421		.019	
1919	do	28,341,366	669,436		.023	

Divi-divi—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Months.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	$45–$55	$45–$55	$45–$55	$55–$75	$50–$55	$55	$65–$70	$70–$73	$85–$87
April	45– 55	45– 55	45– 55	40– 45	55– 56	65	65– 70	73– 75	76– 85
July	45– 55	45– 55	45– 55	35– 40	65– 67	62	73– 75	70– 75	65– 70
October	45– 55	45– 55	55– 75	40– 45	50– 55	65–$68	70– 80	82– 85	.....

Divi-divi, 25 per cent basis (extract)—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Months.	1916 [1]	1917	1918	1919	1920
January	.....	4–4½	5½	5½–6	5–5½
April	.....	.....	5½	5½–6	6–6½
July	.....	.....	6	5 –6½	6–6½
October	.....	.....	5½–6	5 –5½	.....

[1] Not quoted prior to 1917.

Divi-divi—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	532	Divi-divi	Free.
1883	84	Logwood and other dyewoods, extracts and decoctions of	10 per cent ad valorem.
1890	558	Divi-divi	Free.
1890	26	Extracts and decoctions of logwood and other dyewoods, extract of sumac, and extracts of barks, such as are commonly used for dyeing * * *, not specially provided for in this act.	½ cents per pound.
1894	468	Divi-divi	Free.
1894	18	Extracts and decoctions of logwood and other dyewoods, extract of sumac, and extracts of barks, such as are commonly used for dyeing * * *, not specially provided for in this act.	10 per cent ad valorem.
1897	546	Divi-divi	Free.
1897	22	Extracts and decoctions of logwood and other dyewoods and extracts of barks, such as are commonly used for dyeing * * *, not specially provided for in this act.	½ cents per pound.
1909	557	Divi-divi	Free.
1909	22	Extracts and decoctions of logwood and other dyewoods, and extracts of bark, such as are commonly used for dyeing * * *, not specially provided for in this section.	½ cents per pound.
1913	475	Divi-divi	Free.
1913	30	Extracts and decoctions of nutgalls, Persian berries, sumac, logwood, and other dyewoods, and all extracts of vegetable origin suitable for dyeing, coloring, or staining, not specially provided for in this section; all the foregoing not containing alcohol and not medicinal.	½ cents per pound.

Court and Treasury Decisions.

Divi-divi extract was held to be dutiable under the provision for extracts and decoctions of logwood and other dyewoods, and extracts of barks, such as are commonly used for dyeing or tanning, not specially provided for in the act of 1897, and not to be exempt from duty as divi-divi, which term was confined to the reddish-brown curved pods of the divi-divi tree or shrub, which are used for dyeing and tanning. (G. A. 4453, T. D. 21261, of 1899.)

GAMBIER.

General Information.

Act of 1913, paragraph 492: Gambier, free.

Gambier extract or liquid gambier extract not specifically mentioned in tariff.

Paragraph 630: Terra japonica, free.

Description and preparation.—The term terra japonica is an old name for gambier and is rarely used at present. Accordingly this provision of paragraph 630 might be omitted in view of the provision for gambier in paragraph 492.

Gambier known also as gambir, cube gambier, yellow cutch, cubical cutch, gambia-catechu, terra japonica, is the solid extract prepared from the leaves, shoots, and twigs of the Uncaria Gambia. It is used chiefly in tanning and dyeing and is not produced in the United States.

The gambier plant is a scandent bush native to Malacca, Sumatra, Cochin-China, and other parts of eastern Asia. It is largely cultivated in the islands of Bintang, Singapore, and Prince of Wales. This plant was extensively distributed by the British botanical tropical gardens for encouraging its cultivation. The British Government regard this as one of the most important plant distributions made.

For the preparation of gambier catechu, the shoots, leaves, and twigs are gathered two to four times per year. After chopping into small pieces they are extracted by boiling water with continual stirring for about six hours in open iron pots. The insoluble vegetable matter is then removed by a strainer. When on continued evaporation the extract becomes thick and sirupy it is poured into wooden tubs, in about 25 minutes it contracts, thickens, and solidifies, the crystallization being induced by a peculiar stirring. After cutting into cubes, flakes, or cakes, it is allowed to harden.

The recognized varieties of the trade include: Nos. 1 and 2 cube or block gambier, plantation gambier, Java cubes, Singapore cubes.

Cube gambier, common or block gambier, is imported in large blocks covered with a straw mat, weighing up to 200 pounds. Frequently, these are pasty in the center. This condition occurs in both the No. 1 and No. 2 grade. This variety is imported in larger quantities than the three other varieties.

Plantation is a refined clean gambier produced in Sumatra. Singapore cubes occur as the No. 1's, free square cube about three-fourths of an inch in diameter, and No. 2's, the latter consisting of rejections from No. 1's and are pressed in bales. Java cubes were imported during the war in considerable quantity from Java. These did not give satisfaction for tanning and dyeing. The tannin content of the different varieties is from 30 to 40 per cent. The liquid extract is marked as a 25 per cent tannin content.

Gambier is brittle to friable, externally of a dull grayish color and internally somewhat lighter in color. It possesses a bitter, astringent, and finally sweetish taste. The inferior grades steam when opened and often have dark and dirty blue patches. The color of the low-grade gambier as a whole varies from brown to black and the odor is frequently sour and fetid. It is prepared by mixing the ordinary extract with extract prepared from the residue remaining from a previous extraction.

The Malay natives recognize in addition to the ordinary cube or block gambier "gambier dutoor" of commerce, the following varieties, "gambier bulat" or round gambier—this occurs as biscuit like lumps and is used mostly for chewing; "gambier papan" or table gambier—this occurs as yellow brown thin tablets for chewing; and "gambier papu"—nail or finger gambier occurring as long black sticks.

Gambier contains the tannin catechin and catechu-tannic acid. Catechin forms colorless needles readily soluble in boiling water and cold alcohol. Although it is frequently referred to as catechuic acid, it is neutral to litmus and possesses no acid properties. Catechin dissolves in alkaline solutions, turning brown on exposure to air. An aqueous solution precipitates with lead or mercury salts and albumen, but it does not precipitate gelatin, alkaloids, or tartar emetic. Catechu-tannic acid forms a red brown powder soluble in water and alcohol. Its aqueous solution is precipitated by gelatin, albumen, and sulphuric acid. Its alkaline carbonate solution readily oxidizes on exposure to aid to a reddish color; in acidification of this solution a dark red precipitate is formed, rubinic acid. Its solution in caustic alkalies oxidizes on exposure to air to a dark brown color; on acidification a black brown precipitate is formed, japonic acid. This substance is also formed by oxidation with sodium or

potassium dichromate; the dyeing character of gambier depends upon these brown oxidation products.

Uses.—Gambier is used in large quantities in tanning and dyeing. It is also used in textile printing and as an ingredient of boiler compounds for prevention of scale formation. Special grades have a limited use in medicine.

The chief use of gambier is as a tannage. It is used on both light and heavy leathers, in combination with oak, hemlock, and other tanning agents. Gambier rapidly penetrates leather, giving a soft, porous tannage, as it has less astringency and adhesion to the fiber than most tanning materials. These properties make it of particular value in certain stages of the tanning process; it has small use alone in tanning. In combination with sumac it yields a fine soft leather on calfskins, sheepskins, kangaroo, etc. It is also used in tanning horsehides.

Gambier is used in the production of "cutch brown" on cotton goods with copper and chrome mordants. It is of excellent fastness to light, acid and alkaline and bleaching solutions. It is also used in dyeing compound shades with logwood and fustic and as a mordant for fixing "basic dyes." In addition it serves as a weighting agent on silk and for dyeing rabbit skins.

Considerably over half the imported gambier is used in tanning.

Imports.—In the prewar period 1910–1914 the imports varied from 17,037,805 pounds, valued at $784,931, in 1913 to 25,208,720, valued at $1,264,023, in 1910. During the war period 1914–1918 the imports gradually decreased from 16,449,663 pounds, valued at $625,855, to 8,956,082 pounds, valued at $953,000, in 1918. This decrease in importation was largely due to the scarcity of shipping during the war, the price increase was due to a gambier shortage, when the imports decreased and consumption of tanning materials for military leather increased.

In 1909 over 97 per cent of the imports were furnished by the Straits Settlements, small quantities being furnished by transshipment from Belgium, England, and Germany. In 1918 the Straits Settlements furnished over 74 per cent of our imports and the Dutch East Indies over 24 per cent.

Prices.—Gambier Singapore cubes were quoted at 7–8 cents per pound in 1915; 19½–22 cents per pound in 1916, and 18¼–20¼ cents per pound in 1917. In July, 1918, the maximum price of 35–35½ cents per pound was reached. From this point it dropped to 17–18 cents per pound in April, 1919, and in January, 1920, was quoted at 18–18½ cents per pound.

Gambier Java cubes were quoted at 4–6½ cents per pound in January, 1915; 12¾–14½ in January, 1916 and 1917. The maximum figure, 22 cents per pound, was reached on April 22, 1918. From this price it receded to 13–14 cents in the latter half of 1919. In January, 1920, it was quoted at 13–14 cents per pound.

Gambier plantation was quoted at 5–5¼ cents per pound in 1915; 15–16½ cents per pound in 1916; 14¾–15¼ cents per pound in 1917. During 1918 it reached its maximum price of 24–25 cents per pound in July; from this figure it gradually receded to 12–12½ cents in January, 1920.

Gambier cube No. 1 in the period 1912 to April, 1914, is quoted at 9–9½ cents per pound. In July it is quoted at 5⅝–6 cents; no quotations are given after that date.

Domestic preparation of liquid extract from gambier.—Many of the smaller firms not equipped with dissolving tanks purchase the liquid extract. The larger firms, however, dissolve their gambier.

The liquid extract is prepared by dissolving the solid in hot water, in open tanks provided with false bottoms and steam coil. It is supplied to the trade as an extract of 25 per cent tannin. The preparation of this extract constitutes the only domestic industry engaged in the preparation of gambier for the market.

In 1914 the census shows a domestic production of 704,763 pounds of liquid gambier extract, valued at $26,400.

TARIFF CONSIDERATIONS.

Gambier is of foreign origin and is not produced in the United States. It has been free from duty as far back as 1883. The properties of gambier as a tannage are not identical with the domestic tanning materials, such as chestnut, oak, hemlock, sumac, and yet is indirectly competitive with them; very large imports of gambier would tend to decrease consumption of these domestic tannages. There is at present no tariff problem connected with the solid.

The liquid extract, although not specified, is also free. Importation of extract would offer competition to those firms engaged in the preparation of liquid extract for the smaller tanneries. It is estimated that less than one-fifth the imported gambier is thus dissolved before marketing.

Most of our gambier is imported from the Straits Settlements and the greater freight cost of the liquid extract over the solid favors importation only of the solid gambier. No importations of liquid gambier are listed in the Commerce and Navigation. Gambier extract is not specifically mentioned in the tariff. It does not at present offer a tariff problem.

Gambier extract—Production in United States—States and cities.

Census of 1914:		
Quantity	pounds..	704,763
Value		$26,400

Gambier—Imports by countries (fiscal years).

Imported from—	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Belgium	139,632	$6,349	95,899	$6,023		
England	314,725	14,267	952,122	59,163	295,515	$15,178
Germany	79,968	3,451	95,687	6,409	34,304	1,967
Straits Settlements	30,457,920	1,289,930	24,220,222	1,170,774	18,383,585	950,541
Dutch East Indies						
All other			208,725	12,927	51,103	2,472
Total	30,992,245	1,313,997	25,572,655	1,255,296	18,764,507	970,158

Gambier—Imports by countries (fiscal years)—Continued.

Imported from—	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value
	Pounds.		*Pounds.*		*Pounds.*	
Belgium					1,461	$79
England	425,897	$18,772	164,732	$12,857	200,357	8,436
Germany					547	27
Straits Settlements	20,576,756	1,012,267	16,820,173	772,669	14,193,300	541,767
Dutch East Indies			56,000	2,555	538,182	20,643
All other	142	8	24,093	2,000	2,282	115
Total	21,002,795	1,031,047	17,064,998	790,081	14,936,129	571,067

Imported from—	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
England	1,081,144	$47,598	731,259	$64,489	621,122	$52,649
Straits Settlements	12,961,002	486,479	11,464,658	797,901	9,022,933	706,809
Dutch East Indies			215,537	16,489	178,717	15,466
All other	127,344	8,123	408,405	50,045	310,853	84,949
Total	14,169,490	542,200	12,819,859	928,924	10,133,625	859,873

Imported from—	1918		1918 [1]		1919 [1]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
England	202,532	$24,614				
Straits Settlements	6,538,124	670,596	7,099,396	$756,539	4,608,868	$409,778
Dutch East Indies	2,212,558	257,519	1,541,694	168,473	135,743	22,720
Canada			8,750	3,352		
Japan			114,180	24,959		
All other	11,618	2,623			40	1
Total	8,964,832	955,352	8,764,020	952,323	4,744,651	432,499

[1] Calendar years.

Gambier or terra japonica—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	31,000,855	$1,313,990		$0.042	
1910	do	25,808,720	1,264,023		.049	
1911	do	18,910,012	979,036		.052	
1912	do	20,886,462	1,029,456		.049	
1913	do	17,037,805	784,931		.046	
1914	do	16,449,663	625,855		.038	
1915	do	14,169,520	542,200		.038	
1916	do	12,602,251	888,985		.070	
1917	do	10,861,004	853,675		.078	
1918	do	8,965,082	953,000		.106	
1919	do	5,909,382	654,211		.111	

Gambier, plantation—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Months.	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	5 5¼	15–16½	14¾–15¼	18–20	20–21	12 –12½
April	(1)	(1)	.....	20–21	16–17	12 –12½
July	(1)	(1)	.....	24–25	16–17	11½–12
October	(1)	(1)	.....	20–21	14–15	11½–12

[1] Not listed in 1917 Annual.

Gambier, cube No. 1—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Months.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	9–9½	9–9½	9 –9½	.....	.....	.....	.....	.....	.....
April	9–9½	9–9½	9 –9½	.....	.....	.....	.....	.....	.....
July	9–9½	9–9½	5½–6	.....	.....	.....	.....	.....	.....
October	9–9½	9–9½	.....	.....	.....	.....	.....	.....	.....

Gambier, Java, cubes—Prices per pound, wholesale, New York.

[Oil, Paint, and Drug Reporter.]

Months.	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	4–6½	12½–14½	11–12½	21–23	19–19½	13–14
April	.....	.....	.....	22	19–19½	13–14
July	(1)	(1)	.....	18–20	13–14	9–10
October	(1)	(1)	.....	19–19½	13–14	8½– 9

[1] Not listed in 1917 Annual.

Gambier, spot, ex. store—Prices per pound, wholesale, New York.

[Oil, Paint, and Drug Reporter.]

Months.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	6⅛	4⅞–5	4½	5½– 6	18	[1] 11½	[1] 21–21	[1] 20 –22	[1] 11½–12
April	5½–6	4⅝	4½	8– 8½	16–18	15½	[1] 23–25	[1] 12 –15	[1] 11½–12
July	5½–5⅝	4⅝	4½–4½	8– 9	12–12½	16–16½	[1] 24–25	[1] 11 –13	[1] 10½–11
October	5½–5½	4½	6½–8	11–11½	9½–10	16	[1] 21–23	[1] 11½–12	[1] 10½–11

[1] Common.

Gambier, Singapore, cubes—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	7-8	19½–22	18½–20½	30–31	27–28	18–18½
April	(1)	(1)	.....	33	17–18	17–17½
July	(1)	(1)	.....	35–35½	18–18½	14–15
October	.....	.....	.....	28–31	18–18½	13–14

[1] Not listed in 1917 Annual.

Gambier, liquid, 25 per cent tannin—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918	1919	1920
	Cents.	*Cents.*	*Cents.*
January	15	17–17½	12–13
April	17	13–15	10–12
July	17	13–15	9–10
October	17	12–13	9–10

Gambier—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	535	Gambier	Free.
1890	589	.....do	Do.
1894	494	.....do	Do.
1897	563	.....do	Do.
1909	575	.....do	Do.
1913	492	.....do	Do.

Terra japonica—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	806	Terra japonica	Free.
1890	735	.....do	Do.
1894	735	.....do	Do.
1894	652	.....do	Do.
1897	682	.....do	Do.
1909	694	.....do	Do.
1913	630	.....do	Do.

HEMLOCK BARK AND EXTRACT.

SUMMARY.

Hemlock bark is obtained from the North American hemlock *Tsuga Canadensis*. The extract is made by hot water extraction of the bark. Hemlock has been the staple tannage of North America. Previous to 1900 it was the most important domestic tanning material, as it was available in large quantities at low cost. At present it ranks second to chestnut. It is the most important domestic bark used for tanning.

The annual cut of hemlock bark is decreasing on account of the gradual exhaustion of standing hemlock forests, together with the increased cost of bark production and the introduction of cheaper imported tanning materials. The present bark-producing States, in order of their importance, are Pennsylvania, Wisconsin, Michigan, New York, West Virginia, and Maine.

Reported estimates indicate about 33 billion board feet of standing hemlock in the Lake States and the Southern Appalachian region.

The western hemlock offers a large supply of tanning material for the future. There is estimated to be 90 billion board feet of standing hemlock in the Western States and Alaska. This is used, at present,

only to a very small extent by several local tanneries on the Pacific coast. On account of transportation costs to the East, it can not compete with the eastern hemlock and chestnut, or the imported quebracho, mangrove, and other foreign tanning materials.

The acceptance of hemlock as a lumber material, together with its use for wood pulp has eliminated a wastage of hemlock trees, previously cut for the bark alone. There is a greater economy in modern bark-harvesting methods.

The manufacture of hemlock extract is carried on in Michigan, Wisconsin, and North Carolina. In 1914, 18,978,013 pounds of extract were made in the United States, valued at $340,402. Only a very small part of the hemlock bark is converted into extract, most of it being leached direct by the tanner.

General Information.

Act of 1913, paragraph 624: Extract of * * * hemlock bark * * * and other barks * * * and articles in a crude state used in dyeing or tanning, free.

EASTERN HEMLOCK.

DESCRIPTION.

Hemlock bark is obtained from the North American hemlock, *Tsuga Canadensis*. It has been the staple tannage of North America and at present ranks second to chestnut in importance. Hemlock is the most important domestic bark used in tanning. The tannin content of the bark averages from 8 to 10 per cent. This bark by hot-water extraction yields hemlock extract, an important tanning material.

The extract is marketed as a liquid extract of 51° Tw., of 25 per cent tannin, and a powdered extract of 50 per cent tannin. Hemlock contains a catechol tannin with dark-red phlobophanes. The hemlock tannin is probably related to quercitannic acid of oak and is similar to that of mimosa.

USES.

Hemlock has been the staple tannage of North America for sole and heavy leather, sheepskins, etc. It gives a firm heavy leather of a dark-red color. In combination with oak it produces "union" tanned leather. Hemlock with quebracho gives leather of excellent pliability toughness, good color, weight, and fullness.

DOMESTIC PRODUCTION.

Materials.—Hemlock bark obtained by peeling hemlock logs is the raw material used in the manufacture of hemlock extract. Hemlock occurs in the white-pine region of Eastern North America, including New England, Appalachian Mountain belt, Michigan, Wisconsin, extending from northern Michigan roughly along the forty-seventh parallel of latitude to Nova Scotia. About two-thirds of the total cut comes from Wisconsin, Michigan, and Pennsylvania, in the order named, with West Virginia, New York, and Maine following.

The standing hemlock in the Lake States was estimated by the Bureau of Corporations in 1910 to be 26,600,000,000 board feet. Hemlock comprises 34.6 per cent of the standing timber in Michigan and Wisconsin. The Forest Service in 1905–6 obtained an estimate from local timber dealers of 6,700,000,000 board feet for the southern Appalachian region.

Prior to the war hemlock ranked fifth in importance among the lumber trees of the United States. In the early days of lumbering, hemlock was frequently cut from vast tracts, peeled, and not a single log saved for wood. The hemlock tree has been the victim of some of the greatest forest waste in this country. Several of the extract producers report that the available supply of hemlock bark within shipping of their plants will last about 10 years. The increasing scarcity of white pine led to the increased use of hemlock for lumber. In addition, it is now an important wood for pulp used in the manufacture of news, wrapping, and cheap grade papers. The sulphite process is chiefly used for hemlock pulp. This use as a pulp material has resulted in the utilization of large amounts of mill waste and defective logs formerly left in the woods to rot. In Wisconsin about two-thirds of the hemlock, including logs and cordwood, is sold with the bark, and one-third peeled.

Harvesting.—The bark is peeled in the spring when the sap is moving. The peeling season in the Northern States is from May to July, or later, while in Pennsylvania, West Virginia, and Virginia the season may be from April to June. Warm, damp weather is the most favorable to rapid peeling. In the East the peeling is usually done with the logging operations.

The crew for peeling usually consists of four men—one spudder, one fitter, and two log buckers. The fitter cuts rings around the tree 2 feet apart, and then splits the bark from ring to ring. He is usually in charge of the crew. The spudder removes the bark with a flat bar or spud. The crew fell the tree, cut off limbs, and saw the tree into log lengths. The bark is leaned against the trunk and allowed to season for one to four weeks and is hauled by sleds or wagons to the railroad. Four men will peel about 240 to 270 cords per season, and from 6 to 8 cords per day.

Cost of producing hemlock bark in 1914.

	Cost per cord
Cutting and peeling	$2.30–$2.60
Hauling to loading	.90– 1.20
Loading	.50– .60
Railway hauling	.20– .30
Supervision	.25– .40
Total	4.15– 5.10

The bark is sold by the cord and ton; 1 cord approximately equals 1 ton. A thousand board feet of lumber yields about one-half cord of bark. For trees averaging below 20 inches in diameter, the bark yield is greater; for trees above this size the yield is smaller. The bark is from 15 to 20 per cent of the total cubic volume of the tree. The pulp mills pay more for the peeled logs than the unpeeled. The peeled logs are cheaper to ship and do not require rossing. Peeled saw logs are apt to check, which reduces their timber value. Bark peeling is conducted more profitably with pulp wood than timber.

Method of production (hemlock extract).—The equipment used in hemlock extract manufacture is all of domestic production. Fresh bark is not as readily extracted as bark that has been in storage, known as cured bark.

In certain cases hemlock bark held in storage for several years has been subject to attack by a beetle. To avoid this damage it has been recommended that bark should not be stored for more than three years. The bark is ground by a disintegrator and carried by conveyors to open wood vats, known as leaches, each holding about 10 tons of bark. These are arranged in a battery of 6 to 14 leaches. Each leach is provided with a false bottom and a vertical spout for running the hot water from the bottom of one leach to the top of the next. Heating coils are frequently placed under the false bottom to maintain the extracting liquor at an elevated temperature.

The leach liquors are run to the settling coolers, where much insoluble matter settles and then direct to the vacuum evaporators where the liquid is concentrated to an extract of 25 per cent tannin content. This product may be reduced to a solid extract or a powder by a special dryer.

Organization.—The bark is harvested and sold by a large number of timber holders and is not under centralized control.

The domestic production of hemlock extract is conducted by independent operators. There are about six extract factories in the United States. Several of these plants are owned by tanneries. One plant has $200,000 invested in extract-plant buildings and land, which represents an approximate investment of $5 per pound per day output of liquid 25 per cent extract.

Geographical distribution.—The bulk of hemlock bark and extract is produced in Pennsylvania, Wisconsin, Michigan, New York, West Virginia, and North Carolina. Formerly Maine and Massachusetts were the chief bark producers, followed by New York and Pennsylvania. Small amounts are cut in Oregon and Washington.

WESTERN HEMLOCK.

DESCRIPTION.

The western hemlock [1] (*Tsuga heterophylla*) is principally found in western Oregon and Washington, British Columbia, and Alaska. It is one of the important trees of northwestern Oregon and western Washington, and constitutes 13 per cent of the forests of the latter State. The tree occurs as a scattering growth and in stands. It is one of the most rapid growing trees of the coastal region. On account of the prejudice against the eastern hemlock, the lumber has been sold under the names of fir, spruce, Alaska pine, etc. Only a small per cent of the western hemlock has been cut, as the logging has been restricted to the areas containing the smallest amount of hemlock. The western hemlock occurs in almost pure stands in a belt of about 30 miles in width following the coast range mountains through Oregon and Washington. Hemlock averages probably 50 per cent of the stand in this belt and in places runs as high as 80 to 90 per cent. The second hemlock belt is found about 50 miles to the east

[1] The mountain hemlock (Tauga mertensiara) found on the higher slopes of the Cascades is of no commercial value at present on account of its inaccessibility.

on the slopes and summits of the Cascade Mountains. It averages about 15 per cent of the stand and often runs as high as 25 per cent. Furthermore, a large amount of hemlock is situated in the higher, less accessible slopes. There is estimated to be 90,000,000,000 feet, board measure, in the United States and Alaska. Of this total, 40,000,000,000, board measure, are in Alaska. Recently western hemlock has been cut for itself alone.

The wood of the western hemlock is superior to that of the eastern and has a large variety of uses, both as a lumber material and as an important material for wood pulp.

Bark.—The production of western hemlock bark is very small in comparison with the annual cut of hemlock logs, and only a fraction of the possible output. The utilization of this bark is only in its infancy.

The extensive use of western hemlock bark for tanning has been hindered by the high transportation costs from the west coast to the eastern tanneries as well as inadequate transportation facilities in the bark region. Shipment of bark or liquid extract has not been commercially feasible, as solid extract can not be placed in the eastern market in competition with imported quebracho from South America. Similar conditions prevail at present in British Columbia, the freight costs to eastern Canada being too high to permit development of the extract.

The bark is thinner than the eastern hemlock, but contains more tannin—10 to 15 per cent (samples of bark from higher altitudes have shown as high as 19 per cent)—as compared with 8 to 13 per cent for the eastern variety. Bark from the Cascade region shows a higher tannin content than bark from the coast region, and bark from Washington contains a higher per cent than that from the same general region in Oregon. In the East, half a cord of bark per 1,000 feet of logs yielding 112 pounds tannic acid is considered an average yield. The western hemlock gives about a quarter of a cord per 1,000 feet, yielding 90 pounds of tannin. This lower yield is due to the thinner bark and method of logging. The yield per acre is reported to compare favorably with that of the eastern hemlock.

Extract manufacture on the Pacific coast.—A plant was started near South Bend, Wash., in 1893, but owing to insufficient capital, mismanagement, and to general financial depression of that period, and, it is said, to the opposition of eastern bark interests, it was soon shut down. The promoters claim, however, to have demonstrated the possibility of a similar enterprise under more favorable conditions. Extract manufacture has not been carried out since that date.

Bark harvesting (western hemlock).—The western logger usually cuts hemlock for the timber alone and does not care to bother with bark peeling. They report that the harvesting of hemlock bark is feasible where hemlock grows in pure or in nearly pure stands. The western logging methods, with donkey engine and the slack cable system, result in much loss of bark and pitting with stones and pebbles which combine to reduce the value of the bark. Furthermore, with this system log roads are not cut, with the exception of main skid roads and cableways.

While it is possible in a large lumbering operation to lay out roads, cut, peel, and haul the bark before the other trees are cut by a separate crew as carried in the East, the loggers state that this separate hem-

lock operation would hamper the subsequent logging of the large-sized trees. Hemlock costs more to log in proportion to its value than the larger sized timber, such as fir, cedar, and spruce. If the hemlock bark not utilized at present was sold at a fair price this would offset in part this difference in cost. Peeling might be carried out at central landings and peeled logs sent directly to the mill. This reduces the possibility of log injury from insects, fungi, and fire.

The peeling season is earlier than in the East, on account of the milder climate. June, July, and August are the dependable months for peeling, although hemlock has been known to peel as early as February. The fogs are not a serious hindrance to drying. In restricted sections, however, curing is difficult on account of excessive dampness. The bark should be removed from the woods before the rainy season, as leaching destroys its value. Unfortunately, the heaviest rains occur in the hemlock regions. Bark from water-driven or towed logs has little tannin value as salt water ruins the bark entirely.

Pacific hemlock as source of tanbark.—The western hemlock forests offer a large supply of bark for tanning. With the exception of Pacific County in Washington, and Linn County in Oregon, transportation facilities must be developed before the bark supply of this region can be utilized. The establishment of pulp mills in this region using peeled hemlock of all sizes in cooperation with extract manufacture would be an important factor in the development of this resource. At present imported South American quebracho extract can undersell western hemlock extract in the eastern market. The present available supply of hides in the Pacific northwest is insufficient to support a tanning industry of any great proportions. The tanneries are bringing some hides from States east of the Rocky Mountains. The development of the tanning industries in that section would enable further utilization of the bark of that region. After the California oak bark is exhausted, hemlock will undoubtedly be further utilized. In the meanwhile, it is an important reserve supply for the future.

History, eastern hemlock.—Until the development of chestnut extract, hemlock bark was the most important domestic tanning material and was a fundamental factor in the development of the tanning industry in America. The early tanneries were located near the supply of bark, as transportation of light hides was more economical than the heavy bark. New England had 51 tanneries in 1650. Oak bark was used at first but the limited supply caused the early adoption of hemlock. Oak was preferred, largely on account of the appearance of oak-tanned leather. The abundant supply of hemlock made possible the development of a large export trade in leather. In 1810 the value of the output of American tanneries is said to have been about $200,000,000. Salem and Peabody, Mass., became large leather centers and Boston the great leather market of this country.

About 50 years ago, as the hemlock became locally exhausted, the tanneries moved south and west from the New England States. Pennsylvania, on account of the large stand of hemlock, became a large producer of bark and leather.

After 1900 domestic chestnut was of great importance. Foreign tanning materials, on account of their higher tannin content and the increased cost of domestic barks, have been introduced and

compete with domestic tanning materials. During the war, on account of the great demand for military leather and the scarcity of ships for import of foreign tanning materials, hemlock bark sold for its highest figure, resulting in greatly increased production of bark. Previously hemlock was cut in large quantities for the bark alone. At present the wood is used for lumber and for wood pulp.

Western hemlock.—In 1893 an extract plant was started at South Bend, Oregon. This plant project was not a commercial success. The only hemlock used at present on the Pacific coast is limited to five small tanneries in Oregon and Washington which use hemlock in conjunction with California oak bark and other tanning materials.

Recently an investigation has been conducted on the possibility of using the bark of western hemlock. No large-scale operations have been developed up to 1921.

Domestic Production and Consumption.

Eastern hemlock.—The domestic production of hemlock bark and extract is gradually decreasing, while the value per cord of bark is increasing. With the exception of 800 cords per year cut in Oregon and Washington and consumed by tanneries in those States, the production of hemlock bark and extract is at present restricted to the East. The total domestic bark consumption of 1900 was 1,616,065 cords, 72 per cent of which (1,170,131 cords) was hemlock. In 1909 the total bark production had decreased to 1,078,910 cords, 65 per cent of which was hemlock and amounted to 698,365 cords. The amount of bark converted into extract is only a small part of the hemlock bark consumed by the tanning industry. In 1900 it constituted about 1 per cent of the total hemlock consumed. In 1907–8 it was slightly above 8 per cent, and in 1909 it was less than 3 per cent.

In 1900, 26,011,714 pounds of hemlock extract were produced in the United States, valued at $563,591. In 1904, 18,833,450 pounds were produced; in 1909, 12,588,078 pounds; and in 1914 19,978,031 pounds, valued at $340,402. In 1919, 2,952,660 pounds of solid hemlock extract, 17,442,192 pounds of liquid extract, and 723,077,342 pounds of hemlock bark were consumed in the United States.

In 1900, hemlock extract represented 19 per cent of the total tanning materials consumed, and in 1909, 3 per cent. Chestnut extract has increased from 17 per cent of the domestic tanning materials in 1905 to 48 per cent in 1909.

Domestic Exports.

Hemlock extract is not separately listed in the exports of the United States. (Commerce and Navigation.) Prior to the war liquid hemlock extract was shipped to Russia and England. It has been estimated that this export did not exceed 10,000 barrels, including that sent to Canada. During the war small amounts of extract were exported to Canada. Some exporters have declared sulphite cellulose extract as hemlock.

FOREIGN PRODUCTION.

Canada is the only foreign producer of hemlock bark and extract, hemlock is the most important tanning material consumed in that country. In 1909, it constituted 61 per cent of value of tanning materials used; the remainder was imported. Data are not available on the production in that country. For the 10 months' period ending January, 1917, the value of the total Canadian exports of hemlock extract was $47,241. Of this amount, extract to the value of $40,260 went to Great Britain, $300 to the United States, and $6,681 to other countries. For the 10 months' period ending 1918 the total value of the hemlock extract was $18,421, and for 1919, $2,765.

The annual value of exports of hemlock bark in the period 1895–1909 varied from a minimum of $174,819 in 1896 to a minimum value in 1908 of $52,087. For the same period the maximum export of hemlock extract was 10,258 barrels in 1896, and the minimum was 4,183 barrels.

IMPORTS.

Our imports of hemlock bark originate in Canada and have decreased to a small quantity in recent years. The maximum recorded import of bark was 20,311 cords, valued at $126,559 in 1909, gradually decreasing to 10,536 cords in 1911, valued at $65,976. In 1912, 5,633 cords, valued at $34,427 were imported. The quantity gradually diminished to 1,118 cords, valued at $7,027 in 1917, and in 1918, 217 cords, valued at $2,624 were imported.

Imports of extract are given for the years 1904, 1910, and 1915. In 1904 they amounted to 9,355,388 pounds valued at $309,242; in 1910, 32,101 pounds valued at $791, and in 1915, 5,263,296 pounds valued at $173,998.

PRICES.

The average price of hemlock bark was $6.28 per cord in 1900; $6.32 in 1905; $8.49 in 1906; $8.60 in 1907; $8.89 in 1908; and $9.21 in 1909. In 1912 $8 a ton was paid on a 250,000-ton contract in West Virginia for bark delivered to the tannery. During the war when the demand was great $11 to $14 per cord was frequently paid.

Hemlock extract (25 per cent tannin) is quoted at 2¾–3½ cents per pound in the period 1912 to July, 1915. In the latter part of 1915 it is quoted at 4–5 cents per pound. During 1916–17–18 it fluctuated from 4–5 to 5½–6 cents per pound, with the exception of the spring of 1918, when the quotation dropped to 3¼–4¼ cents per pound. The quotation for 1919 was 5¼–6 cents per pound, and for January, 1920, 7–7½ cents per pound.

TARIFF HISTORY.

Hemlock bark has been on the free list since 1883.

Hemlock extract, by the act of 1913, was free. By the act of 1897 and 1909 the extract was made dutiable at the rate of one-half of 1 cent per pound. By the act of 1894 it was made dutiable at 10 per cent ad valorem. The act of 1890 made hemlock extract dutiable at at the same rate as the acts of 1897 and 1909.

COMPETITIVE CONDITIONS AND TARIFF CONSIDERATIONS.

The use of hemlock bark and of hemlock extract has gradually decreased in the United States on account of the gradual exhaustion of hemlock timber in the eastern section, with decreased bark production and the introduction of the cheaper domestic chestnut extract and imported tanning materials.

Quebracho extract, mangrove, wattle, valonia, and other imported tannages are competitive with hemlock. Quebracho wood is the most important tanning material of the world. It contains more tannin and is available in quantities calculated to last for over 100 years. Mangrove extract is available in tropical coast swamps in unlimited quantities and is harvested with cheap oriental labor, the transportation cost to the United States is one of the chief factors in its marketability. Owing to the decreased output of hemlock bark, substitution of the latter by domestic chestnut extract, together with the importation of foreign tanning materials, have been necessary to meet the requirements of the tanners. A high tariff on foreign tanning naterials would hasten the exhaustion of the eastern hemlock and develop the utilization of the western hemlock bark. A low tariff admitting the cheaper foreign tanning materials would tend to conserve the domestic supply of eastern hemlock.

The imported bark and extract from Canada have not offered serious competition with the domestic product.

Hemlock, extract of, for tanning—Production in United States—"Official source."

[From Census of Manufactures, Table 101.]

Year.	Quantity.	Value.
	Pounds.	
1899	26,011,714	$563,591
1904	18,833,450	406,619
1909	12,588,078	280,487
1914	18,978,013	310,402

Hemlock bark—Imports for consumption—Revenue.

TANNING MATERIALS, N. E. S.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Cords.				*Per cent.*
1908	Free	8,871	$43,788		$4.94	
1909	do	20,311	126,559		6.23	
1910	do	16,345	95,667		5.85	
1911	do	10,536	65,976		6.26	
1912	do	5,633	34,427		6.11	
1913	do	5,501	31,964		5.81	
1914	do	4,483	25,655		5.72	
1915	do	3,672	19,967		5.44	
1916	do	3,388	17,855		5.27	
1917	do	1,118	7,027		6.29	
1918	do	270	2,624		9.72	

EXTRACTS FOR TANNING.

[Acts of 1909 and 1913.][1]

		Pounds.				*Per cent.*
1910	½ cent per pound	32,101	$791	$160	$0.025	20.29
1915	Free	5,263,296	173,998		.033	

[1] Act of 1913 specifies "Not containing alcohol."

Hemlock, 25 per cent tannin—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	[1] 1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	[1] 2¾–3½	[1] 2¾–3½	2¾–3½	2¾–3½	5½	4 –4½	4¾–5	5½–6	7 –7½
April	[1] 2¾–3½	[1] 2¾–3½	2¾–3½	2¾–3½	4½–5	4 –4½	3½–4½	5½–6	.....
July	[1] 2¾–3½	[1] 2¾–3½	2¾–3½	2¾–3½	5 –5½	[1] 4 –4½	4 –5	5½–6	.....
October	[1] 2¾–3½	[1] 2¾–3½	2¾–3½	4 –5	5½–6	4 –4½	5½–6	5½–6	.....

[1] Hemlock.

Hemlock bark and extract—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	20	Extract of hemlock, and other bark used for tanning, not otherwise enumerated or provided for in this act.	20 per cent ad valorem.
1883	509	Dyeing or tanning: Articles in a crude state used in dyeing or tanning not specially enumerated or provided for in this act.	Free.
1890	26	* * * extracts of hemlock bark	½ cent per pound.
1890	492	Articles in a crude state used in dyeing or tanning not specially provided for in this act.	Free.
1894	18	* * * and extracts of hemlock bark	10 per cent ad valorem.
1894	386	Articles in a crude state used in dyeing or tanning not specially provided for in this act.	Free.
1897	22	* * * extracts of * * * hemlock bark	½ cent per pound.
1897	482	Articles in a crude state used in dyeing or tanning not specially provided for in this act.	Free.
1909	22	* * * extracts of hemlock bark	½ cent per pound.
1909	499	Articles in a crude state used in dyeing or tanning not specially provided for in this section.	Free.
1913	624	Tanning material: Extracts of * * * hemlock bark; * * * and other barks * * * and articles in a crude state used in dyeing or tanning * * * all the foregoing not containing alcohol and not specially provided for in this section.	Do.

MANGROVE BARK AND EXTRACT.

General Information.

Mangrove bark.—Tariff act, 1913, paragraph 624: "Tanning material * * * and articles in a crude state used in dyeing or tanning; all the foregoing not containing alcohol and not specially provided for in this section." Free.

Mangrove extract.—Held free under paragraph 624.

DESCRIPTION.

Mangrove bark, on account of its abundance, wide distribution, rapid growth, and low cost, is considered one of the world's most important tanning materials. The term "mangrove" is commonly applied in the Tropics to all glossy leafed trees without regard to the genus or natural order to which they belong. Mangrove bark is gathered from *Rhizophora mangle*, *R. mucronata*, *Ceriops candolleana*, *C. roxburghiana* and allied species. These are of abundant occurrence in the tidal swamps in all tropical countries where mangrove forms impenetrable barriers, being most abundant on the lower courses of the rivers. It penetrates into the sea as far as low-water mark and up the rivers for miles after the water ceases to be salty. The tree is remarkable in appearance, as the trunk springs from a number of slender, wide-spreading roots, which rise out of the mud 6 or 7 feet from the ground, forming a series of arches. The red or colored mangrove supplies most of the bark.

The bark is a dull reddish brown in color, is very hard and heavy, somewhat fibrous, and covered on the outer surface with a corklike cuticle. The tannin content varies widely; some grades of bark contain as low as 5 per cent tannin and others above 45 per cent. The commercial grades average 22 to 35 per cent tannin. East Coast of Africa mangrove contains 30 to 44 per cent tannin; that from East India and Borneo runs about 40 per cent tannin. Recently bark has been received from the Celebes with a tannin content of 48 per cent. Bark from the Gulf of Mexico runs about 30 per cent tannin.

USES.

Mangrove extracts have extensive use as a tanning material. It is usually combined with other tanning agents as hemlock, oak, chestnut, mimosa, etc., and is chiefly consumed for the tanning of sole and heavy leathers.

It has only a limited application in dyeing for browns on cotton on account of its low tinctorial value. It can be used as a substitute for true cutch when the price permits the use of about 3 pounds of mangrove extract in place of 1 pound of true cutch.

Mangrove extracts are marketed as liquid and solid products. The liquid extracts are made in the United States, while the solid extracts are imported. The solid extract is sold under various trade names, including "solid mangrove extract," "mangrove 55 per cent cutch," "mangrove cutch," the latter was formerly imported as B. S. L. cutch and Santubong cutch. The tannin content of the solid extract is from 50 to 55 per cent. It is a brittle, reddish-brown

solid of vitreous fracture and is imported in large blocks. The solid extract varies considerably in color and solubility according to the method of preparation and the source of the bark. The liquid extract is of a dark red color and is sold on a 25–35 per cent tannin basis. The trade recognizes two varieties of liquid extract; (1) made from bark; (2) liquid extract made by dissolving the imported solid extract.

The mangrove tannin (*Rhizophora mangle, R. mucronata, Ceriops candolleana, C. roxburghiania*) is described as a red amorphous powder belonging to the catechol class and resembling catechutannic acid in its properties. The exact chemical nature has not been settled and varies in the different species. The white mangrove (*Sagunculatis racemosa*) contains a pyrogallol tannin.

OCCURRENCE AND DISTRIBUTION.

The East Indies and Philippines contain almost inexhaustible supplies. Bark gathering and extract preparation is highly developed in Borneo and Java. Portuguese East Africa has large mangrove swamps and has been a large bark producer since the bark was first introduced into Europe, extract is also produced in this colony. Mangrove is abundant on the low coasts of Central and South America. Brazil, Venezuela, and Porto Rico are developing the mangrove bark and extract industry.

Domestic.—The domestic mangrove swamps are restricted to Florida and the Gulf coast. The "Manual of the Trees of North America," by C. S. Sargent, states that these swamps occur along "shores of Florida from Mosquito Inlet on the east coast and Cedar Keys on the west coast to the southern islands; most abundant south of latitude 29°, following the coast with wide thickets and ascending the rivers for many miles, on Cape Sable and the shores of Bay Biscayne sometimes growing at a little distance from the coast on ground not submerged by the tide and here attaining its largest size with tall, straight trunks producing aerial roots * * * ." Data are not available on the area of the Florida mangrove swamps.

The Philippine swamps contain all species of mangrove, the total well developed virgin swamps are estimated by the Bureau of Forestry to cover 520,000 acres; this includes 62,000 acres in Sebuageuy Bay; 25,000 acres in Mendoro, and a fairly compact area in Polawan. The mangrove swamps on the other Islands are too scattered to be of probable value for manufacture of mangrove extract.

The *Rhizophora mucronata, Bruguiera gymmorrhiza,* and the *B. erio* furnish the Philippine supply of mangrove. The *R. mucronata* reaches a maximum diameter of 20 inches but averages a diameter of 10 to 12 inches and a height of 16 to 27 yards. Three average sized trees yielded 308 pounds per tree of bark. The bark has a thin hard outer scale readily removed from the inner bark; the latter is of an orange color, nonfibrous, somewhat pulpy, and contains 50–60 per cent water. The wood has a specific gravity of 1.1, is a good fuel, and is an excellent construction wood in wet places; it contains 4–6 per cent tannin. The average tannin content of the dried bark was 27.6 per cent.

The *R. conjugata* is similar to the preceding; it is less common and constitutes about one-tenth of the bark timber. The bark is slightly

lighter in color and the average of a series of analyses gave 22.8 per cent tannin.

The *Bruguiera gymmorrhiza*, locally known as pototan or petutan, constitutes about one-fourth of the bark-producing trees. The average diameter is 16–18 inches; the average tree yields 420 pounds of bark. The bark contains 32.4 per cent tannin.

The *Bruguiera parviflora*, locally known as langaray or hagalay, is a tall slender tree, abundant in the Philippine swamps. The average yield per tree is 220 pounds of bark, possessing a dark red color, and containing 9.1 per cent tannin.

The *Sonneratea pagatput* reaches 3 feet and over in diameter and the bark contains 11.8 per cent tannin. The *Ceriops Candolleana*, or Teugah, of extensive occurrence in Borneo, is comparatively scarce in the Philippines.

Dry bark cost $14.50 per ton in the Philippines just previous to the war. The utilization of wood in connection with the bark harvesting is an important economic problem in order to avoid the total waste of the wood. It has been suggested to use the peeled logs as firewood, charcoal, and lumber, none of which appear to offer a fair margin of profit.

The *Ceriops tagal* is scarce in Sebuguey Bay. The bark finds use in dyeing. The wood furnishes the bulk of charcoal for the islands. The bark is not important in the Philippines. It contains 31.3 per cent tannin.

The *Xylocarpus granature* is not abundant. The tree reaches a diameter of 20 inches and yields a thin bark, dark outside and bright red inside. The average yield per tree is 44–55 pounds of bark. The wood contains 6–8 per cent tannin and has a grain of beautiful design and color. The *Xylocarpus oboratun* has a diameter of 12–16 inches and is quite abundant in the more elevated parts of the swamp. The tannin content is 23.2 per cent.

The mangrove swamps at Sebuguey will yield 8.1 long tons of fresh bark per acre, containing 28–30 per cent tannin on the dry basis. The bark of larger trees gives the best yield of tannin.

Porto Rico has fairly extensive mangrove swamps. Bark harvesting is under development in that country.

Foreign.—The East Indies has a large area of mangrove. The *Ceriops candolleana*, known to the natives as Bakan or Tengah bark, contains 27 per cent tannin and yields an extract which for tanning purposes has been competitive with cutch (Acacia Catchu). There are five factories in Borneo and one in Java making solid mangrove extract. Mangrove bark is collected in Queensland.

India, according to an estimate of the forest department, has 2,000 square miles of mangrove forests. The *R. mucronata* and *R. conjugata* are the most common species. According to a test, each acre yielded 3 tons of bark. A factory using 20,000 tons per year would require 400 square miles for a 40-year rotation. In a report made in 1913 it was questionable whether the industry would be profitable. Samples examined varied from 21 to 48 per cent tannin content.

The coast of Portuguese East Africa has enormous quantities of red and white mangrove in the tidal swamps. Estimates are not available on the areas of mangrove forest. The red variety is harvested for tanning. The Mozambique Co. has rights for harvesting

several hundred miles of coast. Previous to the war bark was not shipped direct to the United States. This was explained by the fact that Mr. Eugene Becker was financed by a Hamburg concern, and his concern controlled the bark trade. A royalty of $1 a ton for the bark cut was paid to the Mozambique Co. Germany, before the war, furnished most of the United States imports of mangrove bark by transshipment from East Africa.

In South America mangrove bark is derived chiefly from the Rhizophora mangle. Some bark is obtained from other varieties of the *Rhizophora* and also from the *Ceriops*, *Avicennia nitida* (black mangrove), *Avicennia tomentosa* (white mangrove), *Laguncularia*, *Conocarpus*, and *Carsipourea*.

FOREIGN PRODUCTION.

Raw materials.—Mangrove trees are of abundant occurrence in the tidal swamps of the Tropics. The bulk of the world's mangrove bark supply originates from Portuguese East Africa and the East Indies. Bark is harvested in Colombia, Brazil, Guiana, Venezuela, and Trinidad. The Bureau of Forestry has estimated that the well-developed virgin swamps of the Philippines cover over one-half a million acres. Estimates are not available for other areas. At the present rate of consumption there is probably sufficient bark to last as a tanning material for several hundred years, not allowing for reforestation.

Method of production.—Bark stripping is carried out after the trees are felled, somewhat similar to the method used in hemlock bark peeling. In Queensland, and to a limited extent in other places, the bark is stripped from standing trees to a convenient height and the trees left to die with no further utilization. Extract made from fresh bark is lighter in color than that prepared from stored bark which has been allowed to "sweat." The factories should be near the bark supply in order to secure fresh bark. Bark for long shipment must be carefully dried by exposure in separate layers.

Extract preparation was formerly carried out in the East Indies as follows: The bark, after drying, was tied in bundles and extracted by boiling water in open kettles and evaporation accomplished by direct heat in open pans. This operation was carried to a point at which the extract solidifies on cooling and yielded a very dark-red product. This process resulted in the formation of insoluble matter in the extract.

The modern equipment used is similar to that of the sumac-extract industry. It consists of copper extractors for treating the bark with hot water and vacuum evaporators for the evaporation of the liquid to a solid extract. The use of modern apparatus, together with the blending of barks, has resulted in an extract of a lighter color and better quality for tanning.

Organization.—The world's production of either mangrove bark or mangrove extract is not under the control of a trust nor dominated by a single country.

According to recent information, there are five factories in Borneo, with an average yearly output of 2,500 tons each of solid extract, and one factory in Java, with an average yearly output of 1,500 tons.

The only available production data for Portuguese East Africa is for the year 1910. When bark to the value of $90,434 was exported

at that date, no extract industry existed in Africa. Since that time extract plants have been erected, although information is not at hand concerning their output of mangrove extract. A plant on the River Savanne, Portuguese East Africa, has a capacity of 10 tons per day of extract.

The East Indies, Borneo, and Java are at present the chief foreign sources for mangrove extract. Previous to the war Germany was a large extract producer from bark imported from East Africa. The East Indies extract maker has cheaper oriental labor and smaller transportation cost on bark from the wood to the factory. The imported solid extract must be first dissolved before use, whereas the domestic-made extract is liquid and ready for direct use by the tanner. Production of mangrove extract in South and Central America is being developed. In Colombia the plant at Cartagena and Sinu had in 1918 an annual capacity of 3,000 metric tons of solid extract.

HISTORY OF THE INDUSTRY.

Mangrove is recorded as a tanning material in the early part of the sixteenth century in San Domingo. In Europe mangrove was used as far back as 1804. It is one of the cheapest tanning materials, and while the color was at first not regarded with favor, the low cost led to its extended use. The bark harvesting and extract manufacture were developed in the East Indies. Germany developed the bark harvesting in Portuguese East Africa previous to 1910. The use of mangrove in the United States is of recent date. Small amounts were imported for tanning prior to July, 1897. The first mangrove extract imported into the United States was manufactured in Germany. The term "cutch" applied to mangrove extract originated about 1903, when solid mangrove extract was first imported. This product was not specifically mentioned in the tariff, but by the adoption of the term "cutch" it was entered free as a product used for dyeing, although the mangrove extract was imported for tanning and is chiefly used in that industry.

In the United States one plant near Miami is engaged in collecting, drying, and grinding bark from the Florida swamps. During 1906–1908 extract was made from Florida bark by a plant at Miami. The production of extract in Florida from domestic bark was discontinued largely on account of high transportation costs.

DOMESTIC PRODUCTION.

Bark.—The United States is a small producer of bark—about 100 tons per month. In 1920 one plant was making extract from imported bark. A considerable part of the imported bark is leached direct by the tanneries.

One plant located on the Shark River on the west coast of Florida between Miami and Key West is engaged in collecting, drying, and grinding mangrove bark. This product is shipped to Key West by small sailing vessels, and reshipped by steamer to New York. The production of this plant is approximately 100 tons per month. The domestic bark is sold under a guarantee of 32 per cent tannin content. There is a fairly large amount of mangrove bark available in the Florida swamps. The labor cost of harvesting is much higher than

the cost in the East Indies and Africa. Bark harvesting operations are of comparatively small scale in Florida.

A plant situated at Miami, Fla., began manufacture in 1906 of both mangrove and palmetto liquid extract from raw materials available near by. In 1908 operations were discontinued, the project being unprofitable. According to their report, this was due to the high cost of transportation of raw material and finished product and the low cost of the imported mangrove.

The wood has been exploited in southern Florida. The lumber was sold for flooring and interior finish. The transportation costs of logs and bark were too high to permit development of this industry.

Extract.—The American Extract Co., of Port Allegheny, Pa., operates the only domestic plant for extract manufacture. This plant uses imported bark from the east coast of Africa, Central and South America, with small amounts of Florida bark.

Domestic production and consumption.—The United States does not manufacture sufficient mangrove extract to meet the domestic demands.

Domestic production of mangrove extract is not separately given in the census.

IMPORTS.

In the prewar period 1909–1913 the maximum import of mangrove bark was 23,744 tons, valued at $560,531, in 1911, and the minimum import 12,263 tons, valued at $250,409, in 1909. In the period 1914–1918 the maximum import was 21,107 tons, valued at $581,190, in 1916, and the minimum 3,529 tons, valued at $72,956, in 1918. Scarcity of shipping and high freight rates are largely responsible for the smaller importations in the 1914–1918 period. The bulk of mangrove bark imported in the prewar period came from Germany by transshipment from Portuguese East Africa, with smaller quantities from Dutch West Indies, Portuguese Africa, and Venezuela. In 1910, 86 per cent of the bark came from Germany, 8 per cent from Dutch West Indies, and 0.5 per cent from Venezuela. In 1912, 70 per cent came from Germany, 4.5 per cent from Portuguese Africa, and 2 per cent from Venezuela, and a small amount from Dutch West Indies. Of the 1914 imports of bark, 72 per cent came from Germany, 7 per cent from the Straits Settlements, 6.9 per cent from China, 5.7 per cent from Venezuela, 2.1 per cent from British South Africa, 2 per cent from England, 2 per cent from Colombia, 1.1 per cent from German Africa, 7 per cent from Spain, 0.3 per cent from Madagascar, and 0.2 per cent from France. After 1915 Germany ceased to be a source of supply, shipments then coming direct from Portuguese Africa, with small importations from Venezuela and Brazil. Nearly all of the imported mangrove extract came from Borneo and Java. Imports for mangrove extract are not separately listed in Commerce and Navigation. In 1914, 1,981,266 pounds of mangrove extract, valued at $59,899, were imported; 96.2 per cent of this amount came from the Straits Settlements, 3 per cent from British North Borneo, 0.6 per cent from England, and 0.2 per cent from British India.

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PRICES.

Mangrove bark quotations are not listed. The dutiable value on bark in the period 1909–1918 varied from a minimum of $20.42 per ton in 1909 to a maximum of $28.20 per ton in 1917.

Liquid mangrove extract in the early part of 1918 was quoted at 6–8 cents per pound; this price remained throughout 1919 and for January, 1920.

'Mangrove, 55 per cent cutch,'' was quoted at 10–15 cents per pound for the first quarter of 1919, decreasing to 9–15 cents the remainder of 1918 and for the first half of 1920.

TARIFF HISTORY.

Neither mangrove bark nor the extract has been specially provided for.

COMPETITIVE CONDITIONS.

Bark harvesting can be conducted in the East Indies, Africa, and South America with cheaper labor than is available in Florida. The domestic manufacturer of extract from imported bark has the extra burden of freight on the imported bark, which is larger per unit of tannin than on the higher concentrated solid extract. Liquid extract made from bark is considered preferable by many tanners to the liquid extract made from imported solid extract.

TARIFF CONSIDERATIONS.

Mangrove bark and extracts are chiefly used as a tanning material. Mangrove extract derived from mangrove is of sufficient importance so that it might well be specifically mentioned with the tanning materials. Imported mangrove extract is competitive with the domestic extract made from imported bark and also with the domestic tanning materials—chestnut, hemlock, oak, etc. There is a decreasing supply of the latter two tanning agents, so the tariff problem of mangrove competition is largely restricted to chestnut extract.

Mangrove bark—Imports by countries, by fiscal years.

Imported from—	1909		1910		1911	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Dutch West Indies	1,922	$27,044	1,290	$16,558	.....	.....
Germany	6,709	153,712	13,940	377,631	.....	.....
Portuguese Africa	1,800	39,344	.....	.....	.....	.....
Venezuela	932	10,600	818	7,946	.....	.....
All other	900	19,709	41	718	.....	.....
Total	12,263	250,409	16,089	402,853	.....	.....

Imported from—	1912		1913		1914	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Dutch West Indies	110	$1,419	.....	.....	.....	.....
Germany	15,277	353,947	10,554	$233,306	4,366	$105,193
Portuguese Africa	1,009	24,357	3,474	84,317	2,862	74,848
Venezuela	594	6,865	594	8,209	87	1,184
All other	4,789	97,332	565	10,304	374	15,666
Total	21,779	483,920	15,187	336,136	7,689	196,891

Mangrove bark—Imports by countries, by fiscal years—Continued.

Imported from—	1915		1916		1917		1918	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Dutch West Indies			755	$10,371	283	$6,256		
Germany	50	$1,707						
Portuguese Africa	5,796	162,006	12,880	397,621	7,341	197,546	1,635	$13,111
Venezuela	417	7,190	3	48			5	93
Brazil					5	130	270	14,580
All other	1,833	48,049	7,548	174,882	2,936	95,965	1,619	45,172
Total	8,096	218,952	21,186	582,922	10,565	299,897	3,529	72,956

Mangrove bark—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Tons.				*Per cent.*
1909	Free	12,263	$250,409		$20.42	
1910	do	17,088	402,853		23.58	
1911	do	23,774	560,531		23.58	
1912	do	21,561	480,878		22.30	
1913	do	17,578	374,506		21.31	
1914	do	7,743	191,472		24.73	
1915	do	8,326	222,060		26.67	
1916	do	21,107	581,190		27.54	
1917	do	10,565	297,897		28.20	
1918	do	3,529	72,956		20.67	
1919	do	2,817	125,603		44.40	
1920 [1]	do	1,564	81,636		52.20	

[1] Jan. 1 to July 1, 6 months.

Mangrove, liquid, 25 per cent, prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918	1919	1920
January		8-10	8-10
April	6-8	8-10	8-10
July	8-10	8-10	8-10
October	8-10	8-10	8-10

Mangrove, 55 per cent cutch, prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918	1919	1920
January		10-15	9-15
April	10-12	9-15	9-15
July	10-15	9-15	10-12
October	10-15	9-15	10-12

Mangrove bark—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	624	Tanning material * * * and articles in a crude state used in dyeing or tanning; all the foregoing not containing alcohol and not specially provided for in this section.	Free.
1909	499	Articles in a crude state used in dyeing or tanning not specially provided for in this section.	Do.
1897	482	Articles in a crude state used in dyeing or tanning not specially provided for in this act.	Do.
1894	386	....do....	Do.

Mangrove extract not specifically mentioned.
Held free under the act of 1913 (Abstract 38085, of 1915).
For the decisions, see the Survey on Cutch, *infra*.

MYROBALANS AND MYROBALAN EXTRACT.

General Information.

Paragraph 553, act of 1913. "Myrobolans fruit," free.

United States Board of Appraisers, January 11, 1915, under paragraph 624, act of 1913, myrobalans extract, free.

DESCRIPTION.

Myrobalans are the dried fruit of different species of Terminalia growing in India and China. Imported species are *Terminalia Chebula* and *Terminalia Belerica*. The fruit of the *Phyllanthus Emblica* is also used. It is variously spelled, myrabalons, myrobolans, myrabolams, etc. The myrobalan plum (*prunus cerasijera*) is an entirely different product.

The principal myrobalans is the Chebulic or black Myrobalan, fruit of the *Terminalia Chebula*, a deciduous tree found throughout India and Burma. The Flora of British India enumerates six varieties. The five chief varieties of Chebulic myrobalans of commerce are named after the districts in India whence they are obtained: 1, Bhimlies; 2, Rajpores; 3, Jubbelpores; 4, Vingorlas; 5, Madras coast. The Beleric myrobalan, the fruit of the *Terminalia Belerica*, is of less value than the Chebulic. The tanning properties of the different varieties differ slightly. They are graded and sold on the basis of color. The trade designates the different varieties as: B's, R's, J's, V's; the first grade lightest in color as B_1, R_1, J_1, V_1; and the second grade as B_2, R_2, J_2, V_2. The second quality or grade is darker in color than the first grade. Most of the first grade (1's) go to England and are less available in the United States. In case of dispute on the quality, the question is referred to the London Board of Arbitration for settlement.

The *Terminalia Chebula* is an important Indian forest tree. Most of the forests are under government control. The tree reproduces itself well by seedlings and sprouts. It is long lived and yields fruit in commercial quantities after its fifteenth year. The timber, although of value, is of secondary consideration in comparison to the fruit. The fruit is auctioned while on the tree and gathered by natives from October to March. It is dried on the ground or on stones in direct sun. The ultimate commercial value depends on the

drying process. If wet by rain during this operation, the fruit is spoiled. The dried fruits resemble a slightly shriveled plum. They are hard, about 1 inch in length, and possess a bitter astringent taste. The peel surrounding the kernel contains most of the tannin. Considerable economy of freight would result in cracking the nuts in India and exporting only the tannin containing shells. Due, however, to the comparative ease with which the crushed product may be adulterated and the difficulty of adulterating the whole nut, the trade has a strong preference for the whole nuts. As imported, the dried myrobalans contain 3 to 7 per cent water and yield about 10 per cent ash on ignition. Myrobalans is a pyrogallol tanning material. The tannin is largely ellagitannic acid; the content is 30 to 40 per cent. In addition, there are present small quantities of brownish coloring matters.

USES.

Myrobalans is an important tanning agent. It has limited application in the dyeing of blacks and as mordant in fixing basic colors. In Bombay it is used for dyeing a buff shade on cotton. Myrobalans also have application in the manufacture of inks. In tanning, myrobalans is used in conjunction with other tanning agents. If used alone the leather is porous, soft, mellow, and of good color and fair weight. As a substitute for the more expensive sumac it is used on the light leathers. It has large use in the tanning of sole leather. In admixture with darker tanning agents as hemlock, it is of great value on account of its tannin strength, brightness of color, and the light colored bloom it rapidly deposits in or on the leather.

Of great importance is the acidity developed by myrobalans which in the tanning process neutralizes the lime left in the leather after the liming process, and also "plumps" the leather thereby assisting in the ready uniform penetration of the tannin. These essential organic acids result from the fermentation of nontannin matters in the myrabolans.

Manufacture of extract.—The hard fruit first receives a coarse crushing to break the outer shell. Care is taken to avoid crushing the kernel as the extract from the broken nut lowers the quality of the final product. The extraction is carried out with boiling water in copper autoclaves arranged according to the counter current system. The water used should be soft and free from iron. The liquid, after filtration, is evaporated in triple effect evaporators to a liquid of 43° Tw. and 51° Tw. with a tannin content of 25 per cent and 30 per cent, respectively. Solid extract is made in smaller quantity. The solid extract contains about 50 per cent tannin and is inclined to become moist and sticky in hot, damp weather.

The equipment used in the manufacture of myrobalan extract is similar to that used in the preparation of sumac extract.

One domestic extract manufacturer produced myrobalan extract during the war. Previous to the war, other plants made myrobalan extract. The investment in equipment is several thousand dollars per barrel per day output. The plants are located on or near the Atlantic seaboard.

DOMESTIC PRODUCTION AND IMPORTS.

The domestic production of myrobalan extract is not separately listed in the Census of Manufactures. In the period 1908–1914, the imports of fruit varied from 19,735,724 pounds valued at $195,264 in 1913, to 55,445,896 pounds valued at $484,570 in 1910. The average annual import for this period was 29,926,744 pounds, valued at $281,121. Assuming the average yield to be 75 per cent of the weight of fruit in terms of 51° Tw. extract, 22,445,058 pounds represents the average annual output of extract in the United States during the above period.

In the period 1915–1918 the imports of fruit showed considerable fluctuation. In 1916, 25,612,765 pounds were imported with a value of $375,401. In 1918 the imports decreased to 4,408,522 pounds, the minimum in the period 1908–1919. The imports of extract are not separately listed in Commerce and Navigation. In 1914 Pickrell [1] gives the import of solid extract as 88,881 pounds, valued at $3,030, and the import of liquid extract as 95,845 pounds, valued at $2,237. In both cases the source of the imports was England. The imports consist largely of the fruit, with small amounts of extract; the extract imported is only given for 1914.

Previous to 1910 a considerable part of our imports of myrobalans came from England, although these originally came from India. In 1910 the United States imported 33,418,896 pounds from India, and 14,614,544 pounds from England. In 1915, 1917, 1918, no imports came fom England and in 1916, 60,592 pounds were shipped from this source.

PRICES.

Myrobalans fruit was quoted at $24–$28 per ton in January, 1912. After a small increase the price abruptly rose to $40–$50 a ton in the latter part of 1914. In 1915 the price receded to $30–$35 per ton, increasing during 1916–17 to the maximum of $65 per ton in January, 1918. In January, 1920, myrobalans was quoted at $55–$60 ton ton.

TARIFF HISTORY.

Myrobalans fruit is on the free list. The extract although not specifically mentioned is duty free. (Abstract 37917 of 1915.)

TARIFF CONSIDERATIONS.

Myrobalans fruit is a tanning material of foreign origin; it does not grow in the United States. Domestic manufacturers of myrobalan extract have reported keen competition with the foreign-made extract in the prewar period. It is indirectly competitive to domestic tanning materials. The tariff problem is largely restricted to chestnut extract.

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[1] Pickrell, Dr. E. R.: "Chemicals and Allied Substances used in the U. S. Department of Commerce, Misc. Series No. 82.

Myrobalans.

EXPORTS FROM INDIA.

Countries.	1909–10		1910–11		1911–12	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	72,187,808	$779,755	76,284,544	$842,357	54,524,848	$601,013
Germany	27,192,144	360,432	34,142,304	470,420	26,100,368	334,786
United States	34,427,680	382,487	33,418,896	385,767	25,093,936	273,882
All other	30,508,016	424,062	41,950,496	564,850	32,450,880	413,394
Total	164,315,648	1,946,736	185,796,240	2,263,394	138,170,032	1,623,075

Countries.	1912–13		1913–14		1914–15	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	76,941,760	$888,029	56,448,112	$694,367	72,171,568	$858,393
German	25,607,008	393,199	30,325,904	437,080	13,659,744	218,102
United States	21,465,472	267,176	20,976,256	277,303	21,205,856	284,393
All other	32,534,320	467,690	30,725,856	438,700	23,360,064	344,577
Total	156,548,560	2,016,094	138,476,128	1,847,450	130,397,232	1,705,465

Countries.	1915–16		1916–17		1917–18	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	104,948,144	$1,549,679	89,211,472	$1,555,523	.....	.....
Germany	.....	.....	.....	.....	.....	.....
United States	29,950,704	415,657	14,970,816	186,776	.....	.....
All other	21,079,408	322,683	16,913,120	268,067	.....	.....
Total	155,978,256	2,288,019	121,095,408	2,010,366	.....	.....

Source: Trade of British India with the British Empire and Foreign Countries, 1912–13 to 1916–17.

IMPORTS TO UNITED KINGDOM.

Countries.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
British India	62,643,168	$745,154	95,841,984	$1,089,760	57,256,864	$669,971
All other	.....	.....	554,064	6,020	447,328	5,227
Total	62,643,168	745,154	96,396,048	1,095,780	57,704,192	675,198

Countries.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
British India	64,077,664	$785,638	63,219,744	$859,526	62,619,200	$790,383
All other	504,224	5,879	85,120	1,139	168,000	2,569
Total	64,581,888	791,517	63,304,864	860,665	62,787,200	792,952

Myrobalans—Continued.

IMPORTS TO UNITED KINGDOM—Continued.

Countries.	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds*	
British India	86,341,472	$1,409,226	96,417,552	$2,429,795	75,530,224	$3,112,433
All other	904,736	13,237	96,096	1,650	.....	.....
Total	87,246,208	1,422,463	96,513,648	2,431,445	75,530,224	3,112,433

Countries.	1918	
	Quantity.	Value.
	Pounds.	
British India	83,625,696	$3,879,822
All other British possessions	164,864	6,521
Total	83,790,560	3,886,343

Source: Annual statement of the trade of the United Kingdom with foreign countries and British pos sessions, 1918.

EXPORTS—ENGLAND.

[Fiscal years.]

Exported to—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	3,136	$73	393,904	$4,667	343,616	$4,210
United States	18,471,488	218,389	14,614,544	157,626	109,424	1,635
All other	881,664	10,925	969,024	12,332	441,392	6,278
Total	19,356,288	229,387	15,977,472	174,625	894,432	12,123

Exported to—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	5,376	$83	1,879,696	$22,172	.....	.....
United States	692,160	11,621	340,256	4,998	207,648	$2,336
All other	948,640	10,346	244,384	3,377	1,390,592	23,126
Total	1,646,176	22,050	2,464,336	30,547	1,598,240	25,462

Exported to—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	.....	.....	.....	.....	.....	.....
United States	.....	.....	60,592	$1,329	.....	.....
All other	.....	.....	[1] 3,913,056	129,079	.....	.....
Total	2,745,232	$58,666	3,973,648	130,408	85,232	$2,705

Exported to—	1918	
	Pounds.	Value.
France	499,520	$23,109

[1] 2,075,024 pounds to the Netherlands.

Myrobalan extract—Imports by countries, by fiscal years.

[Source: Department of Commerce, Miscellaneous Series No. 82, Pickrell Census.]

Imported from—	1914		1914	
	Liquid extract.		Solid extract.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
England	95,845	$2,237	88,881	$3,030

Myrobalan fruit—Imports for consumption—Revenue.

Fiscal years.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	20,988,206	$229,441		$0.011	
1909	do	42,667,676	441,584		.010	
1910	do	55,445,896	484,570		.009	
1911	do	23,595,695	184,513		.008	
1912	do	22,797,639	185,277		.008	
1913	do	19,735,724	195,264		.010	
1914	do	24,256,373	247,200		.010	
1915	do	18,417,434	198,347		.010	
1916	do	25,612,765	375,401		.014	
1917	do	16,087,463	421,824		.026	
1918	do	4,408,522	110,444		.025	
1919	do	9,597,836	188,507		.196	
Average for 1908–1914.		29,926,744	281,121		.00942	

Myrobalans, prices per ton.

[From Oil, Paint, and Drug Reporter.]

Kinds or grades.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	$24.00–28	$24.50–32	$28–34	$40–50	$39–40	$60–65	$65	$60	$55–60
April	24.00–30	25.00–32	26–32	30–35	39–40	64–65	65	60	55–60
July	23.00–30	25.00–32	27–34	30–35	56–57	64–65	Nom.	45–50	50–55
October	24.50–32	28.00–34	40–50	34	52–55	64–65	Nom.	55–60	47–50

Myrobalans, rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	549	Myrobalans	Free.
1890	655	do	Do.
1894	560	do	Do.
1897	619	do	Do.
1909	632	do	Do.
1913	553	Myrobalans fruit	Do.

Court and Treasury Decisions.

Myrobalan extract is exempt from duty as tanning material. (Abstract 37917, of 1915.)

OAK BARK AND OAK EXTRACT.

General Information.

Act of 1913.—Paragraph 624, "* * * extracts of oak and chestnut and other barks and woods other than dyewoods, such as are commonly used for tanning, not specially provided for in this section; * * * and articles in a crude state used in dyeing and tanning * * *; all the foregoing not containing alcohol and not specially provided for in this section," * * *. Free.

Description.—Oak bark is one of the oldest and most highly valued tanning agents. It was the basic tanning material of the early American tanneries. At present it ranks third in importance among the domestic tanning materials, being preceded by chestnut-wood extract and hemlock. It is used in tanning heavy and sole leathers and gives a strong leather with a whitish bloom.

The American supply of oak bark is derived in the East, almost entirely from the chestnut oak (*Quercus prinus*) with a tannin content of 8 to 14 per cent. The black oak (*Quercus velutina*) furnishes the natural dye quercitron. This has comparatively small application as a tanning material. White-oak and red-oak bark have only a limited application in tanning. On the Pacific coast the tanbark oak (*Quercus densiflora*) is the source of oak bark for tanning, with a tannin content from 9 to 29 per cent.

The bark of the other American oaks contains notable quantities of tannin. They do not, however, at present furnish large quantities of bark. These include the California black oak (*Quercus californi*), about 10 per cent tannin; highland oak (*Q. wislizeni*), about 7 per cent; California white oak (*Q. labata*), about 12 per cent; canyon live oak (*Q. chrysolepia*), about 10 per cent; Pacific post oak (*Q. garryana*), about 7 per cent and the *Q. facata or digitata.* In Great Britain, Europe, Algeria, and Japan other species of oak are of commercial value as a source of tan bark.

Consideration of domestic oaks is given under two headings: I. California tanbark oak; II. Chestnut-oak bark.

I. California Tanbark Oak.

Description.—California tanbark oak (*Quercus densiflora*) or *Pasania densiflora*, botanically intermediate between the chestnut and oak, is the most important tanning material used in the tanneries of the Pacific coast region.

The bark and extract are used for tanning sole, harness, strap, and heavy leathers. Unlike the eastern chestnut, the wood has no value as a source of tannin. The wood is hard, strong, and close-grained, and it is now used for fuel and lumber, although previously much oak was cut for bark alone. The twigs have a high tannin content but are not at present used as a source of tannin.

The bark of tanbark oak is from three-fourths of 1 inch to 3 inches in thickness, sometimes reaching 5 inches. It is brown and fissured longitudinally and transversely; the bark of the young tree is little fissured and of a gray color. Mature bark, possessing a valuable tannin content, has three layers—a rough outer layer, "ross;" a middle layer, "meat"; and an inner layer, "fiber." A

cross section of the fresh bark of the highest tannin content is deep red in color; bark of low tannin content is yellow. The tannin content of the bark varies from 9 to 29 per cent, averaging about 20 per cent. Second-growth bark contains about 10 per cent tannin.

Oak extract is a brown liquid of 32° Baumé, containing about 25 per cent tannin. According to the present practice in tanning, the tan-oak bark is used in conjunction with quebracho, gambier, and other imported tanning materials.

DOMESTIC PRODUCTION.

Materials.—The tanbark oak is found from southwestern Oregon through the coast ranges to Santa Barbara and from the Humboldt region eastward by the way of the Shasta Mountains to the Sierra Nevada and southward along the latter range to Eldorado County. It is found in or near the redwood belt, where it attains its best development on the tracts which border the redwood areas, and is always found mixed with other trees, including the Douglas fir, madrona, post oak, black oak, and chinquapin. The Santa Cruz and Mendocino district and Sonoma County have been the most important areas of bark production. Northern Mendocino and Humboldt Counties contain the most extensive tracts of uncut oak.

In the forest the tree grows tall and straight, with a spirelike head, while the open growth has spreading limbs with a round-topped crown.

METHOD OF PRODUCTION.

Bark harvesting.—As the tanbark oak grows among the redwoods and the logging of the latter requires a burning which would kill the tanbark oak trees, the bark peeling necessarily precedes the logging operations by one or two years. The redwood lumbering operations have been an important factor in keeping up the supply of bark.

The peeling season runs from about the middle of May to the latter part of August and frequently later. The bark can be removed after the sap begins to run and until the end of the period of the summer growth. The ease of bark removal is subject to changes which result from variation in temperature. A cold spring will delay the peeling season; a moist season may prolong the peeling period. A dry, hot north wind will cause the bark to tighten and a hot wave in July or August will put an end to peeling. In the early part of the peeling season the bark is brittle; in the latter part it is tougher and can be removed without breaking.

The peelers first test the bark with an ax to determine its looseness and then cut two circles through the bark, one at the bottom of the trunk and the other 4 feet above. This first circle, known as a "rim" or "coil," is peeled from the standing tree on account of the easier manipulation and economy from loss in chopping. It is the richest bark in tannin content. After removing the first coil the tree is felled by chopping or sawing. Attempt is made to fell the tree so that the trunk lies favorably for bark peeling. Peelers work in pairs, the first man "ringing"—cutting circles around the bark 4 feet apart—the second slits and pries off the bark.

Bark is removed down to a thickness of one-half inch. The average peeler harvests 1 to 1½ cords per day, although an expert with clear straight ridge growths can peel 4 to 5 cords per day. The small-pole growth is not peeled, but the bark is removed as high as the men can reach; 10 feet is usually the limit. This practice is known as "jayhawking." This method wastes considerable bark. The tree waste and destruction of the second growth are somewhat less than would first appear, as the burning in the redwood logging operations kills a large part of the growth. The "coils" are spread against the log or on the ground—flesh side up—for curing. This requires at least six to eight weeks. The bark curls and hardens, and the changes result in about 30 per cent loss in weight. The dry season of California is very favorable for this curing. In case the bark is left out over winter, it must be roofed over to prevent leaching.

The prewar cost of peeling, bunching, and hauling varied from $5 to $8 per cord. Bark stumpage sold for $1 to $2.50 per cord, which included the tree, generally cut for hardwood. After curing, the bark is bunched up near temporary sled roads and hauled by sled to the main roads and thence by wagon to the railroads. A box car holds 12 to 16 cords of bark; doors or windows are left open to avoid damage by fermentation. The bark chips are frequently gathered and shipped in bags. The bark is ultimately sold by the ton, which varies in different places from 2,200 to 2,600 pounds; 2,400 pounds is the basis of sale in San Francisco.

Extract preparation.—The method and equipment used in the manufacture of oak bark extracts is similar to that described under hemlock extract manufacture. The bark is ground, leached with hot water in open wooden vats, allowed to settle, and evaporated in vacuum pans to a liquid of 25 per cent tannin content. Open-pan evaporation was tried in Mendocino in 1900–1902, but was abandoned on account of the poor quality of the extract. One cord of dry bark, 2,200 pounds, yields 50 gallons of extract weighing about 550 pounds. Extract is now evaporated in vacuum evaporators which permit the use of lower temperature.

Supply of tanbark oak.—The future supply of tanbark oak will come from first growth timber at present not accessible and from the second growth. The available supply of tanbark oak is decreasing while the price is increasing. In 1909, standing bark was estimated to be 1,425,000 cords, sufficient to last about 50 years. Four and two-tenths per cent of this supply was in Oregon and the remainder in California. Bark operators in the fall of 1920 report that at the present rate of consumption—40,000 to 45,000 cords per annum—the present supply will last about 30 or 40 years; on this basis their estimate of the present stand is 1,200,000 to 1,300,000 cords.

The maintenance of a future supply of bark would require (1) an extension of transportation facilities in order to utilize the less accessible tracts, (2) utilization of the second growth, (3) forest fire protection, (4) more conservative methods in the woods, particularly in connection with the red wood lumbering and also in the bark harvesting itself.

Tanbark oak has high reproductive powers. The recent reports on restocking are not encouraging as a basis of an adequate future supply of bark. The stump usually yields a crop of sprouts which give second growth that can be peeled in about 30 to 40 years. Sprout growth is greatly favored by cutting the coil at the foot of

the tree instead of breaking the bark below the ground. The second growth bark contains less tannin—about 10 per cent—and furnishes about 4 per cent of the present supply.

The use of foreign tanning materials, quebracho, gambier, in conjunction with the tanbark oak has been found to be desirable from the tanners' viewpoint, and in addition conserves the supply of oak bark. The use of the barks of other Pacific coast oaks would conserve to some extent the supply of tanbark oak. These other oaks are inferior to the tanbark oak for tanning purposes.

Organization.—The bark harvesting is chiefly carried out by the red wood lumbering concerns, although a large amount of bark is cut by small holders. One firm manufactures extract for sale, the other firms leach their bark for tanning operations.

History of the industry.—The large supply of oak bark in California led to the early establishment of tanneries in that State. One tannery in Sonoma County produced in 1852 $30,000 worth of leather. In 1856 there were 18 tanneries in which $94,000 were invested. Live oak and black oak bark were first employed in tanning. In 1857 a tannery at Santa Cruz demonstrated the superior quality of leather made from tanbark oak. In 1859 the output of 29 tanneries produced leather in excess of local consumption. In 1904 the annual harvest of tanbark oak reached 30,000 cords of bark. At present the annual output is estimated to be 40,000 to 45,000 cords.

DOMESTIC PRODUCTION AND CONSUMPTION (CALIFORNIA TANBARK OAK).

The bark of the tanbark oak is consumed by the tanners of the Pacific Coast States with the exception of about 1,000 cords per year exported to China and Japan. The growth of these domestic tanneries has been dependent on this oak-bark supply. In the period 1855 to 1890, tanoak bark harvested in California increased from 1,000 to 24,000 cords per year. Up to 1907, the yearly production reached 30,000 cords per year. The total production 1851–1907 is estimated to be 861,000 cords.

The present annual cut of bark is estimated at 40,000 to 45,000 cords per year. About 2,500 cords are consumed for the preparation of extracts and the remainder is directly leached by the tanner, with the exception of the export mentioned above.

(For Exports, Foreign production, Tariff consideration, see paragraphs after chestnut-oak bark.)

II. Eastern Oak Bark.

The chestnut oak (*Quercus prinus*) is the chief source of oak bark in the eastern United States. The white oak (*Q. alba*) and red oak (*Q. rubra*) furnished a small amount of tanbark. This tree is known as rock oak in New York, rock chestnut oak in Massachusetts and Rhode Island. In North Carolina it is known as the tanbark oak and swampy chestnut. This tree is widely distributed in the East and is found from southern Maine to Maryland, in the Appalachians southward to Alabama and Georgia and westward to Lake Erie and central Kentucky and Tennessee.

The bark is gray, deeply ridged, although darker in color on the old trees. It contains 8 to 14 per cent tannin, known as quercitannic acid, probably both catechol and pyrogallol in chemical character.

DOMESTIC PRODUCTION.

Oak bark ranks third in importance in domestic tanning materials.

Materials.—Commercial stands of chestnut oak are found in the Appalachians and Alleghenies from south central Pennsylvania through Virginia, West Virginia, Kentucky, central and western Tennessee, and North Carolina. It is most frequently found on upper slopes and ridges in North Carolina. It is found at low altitudes not exceeding 2,500 feet and in the Appalachians at an altitude of 2,000 to 4,000 feet.

Chestnut oak is a vigorous tree, which grows rapidly in dry soil. The most abundant growth and largest trees occur in lower Carolina and Tennessee. The diameter of mature trees varies from 2 to 5 feet, with an average height of about 60 feet. Bark harvesting is conducted in places with sufficient growth to supply a local tannery either alone or in conjunction with hemlock. Western Virginia and West Virginia have many tanneries located near the chestnut-oak bark supply. Previously only the bark was utilized; at present, however, the wood is used for ties, timber, mine props, and for lumber.

The bark of the red oak (*Q. rubra*) and white oak (*Q. alba*) have a lower tannin content, 4 to 8 per cent and 4 to 7 per cent, respectively. As the supply of chestnut oak bark decreases, these oaks offer a limited domestic supply of more costly tan bark. At present these oaks are reported to furnish only a small amount of bark. They are cut for their higher timber value. White oak bark gives a good quality leather; owing, however, to the thinness of the bark, the low tannin content, the large amount of "ross," and the scattered growth of this oak, it is an expensive tanning material. The Spanish oak (*Q. facata* or *digitata*) occurring in the southern United States furnishes some tan bark.

Supply of chestnut oak bark.—The annual cut of chestnut oak bark is decreasing. An estimate made by the forest survey in 1908 indicates the following stands of bark, "estimated on a basis of seven-eighths of a cord of bark for each 1,000 feet of lumber—a proportion calculated for an average tree of 16 inches diameter—is shown in the following table":

	Cords (long tons).
Alabama	43,400
Georgia	40,700
Kentucky	1,064,800
Maryland	10,500
North Carolina	369,400
South Carolina	18,200
Tennessee	689,600
Virginia	467,300
West Virginia	1,980,000
Total	4,683,900

This table is based on an estimate of the stand of chestnut oak and "includes the timber which is suitable for lumber and does not embrace that which would be useful only for ties."

In 1908 about half of the chestnut oak was virgin in central and southern West Virginia, central and northeastern Tennessee, western North Carolina, and northern Alabama; in South Carolina nearly all the chestnut oak was virgin.

In 1920, at the present rate of consumption, the supply of chestnut oak bark is estimated to last about 30 years. While there will be bark cut for many years longer, the annual cut will undoubtedly continue to decrease because the reforestation of this tree is slow.

There is estimated to be a total of 10,000,000,000 board feet of standing chestnut oak. 25 per cent of this is not available to transportation, an additional 25 per cent will be cut for timber during the winter when the bark can not be peeled, leaving approximately 5,000,000,000 board feet as a possible source of bark.

The average yield of chestnut oak bark in cords per tree is as follows: 10 inches in diameter, 0.06 of a cord; 15 inches, 0.1 of a cord; 20 inches, 0.16 of a cord, 25 inches, 0.24 of a cord.

METHOD OF PRODUCTION,

The method of harvesting is similar to that described under hemlock bark. The bark is usually peeled from late in March to the middle of June and allowed to air about dry six weeks in the woods. Shipments of bark begins about June 15 and continues until winter.

The equipment and method used in the preparation of extract is similar to that described under hemlock extract.

Organization.—The harvesting of bark is carried on by a number of independent operators. Extract preparation is conducted by several firms who produce other tanning and dyeing extracts. These two branches of the industry are not under centralized control.

DOMESTIC PRODUCTION AND CONSUMPTION (TOTAL OAK).

In 1914, 8,797,218 pounds of oak extract was made in the United States, valued at $192,844.

In 1918, 3,815,056 pounds of solid oak extract, 34,380,396 pounds of liquid oak extract, and 485,134,791 pounds of bark were consumed in the United States, according to figures furnished by the Tanners' Council, published in Forest Products, by N. C. Brown.

EXPORTS.

Oak bark and oak bark extract are not separately listed in Commerce and Navigation.

FOREIGN PRODUCTION.

Oak bark is harvested and the extract prepared in Great Britain, Europe, Asia, and Japan. Most of the supply is consumed locally and has not offered serious competition to the domestic products by shipment to the United States.

DOMESTIC EXPORTS.

Oak bark and extracts are not separately listed. A small amount of California tanbark oak extract, and approximately 1,000 tons of California tanbark oak per year have been exported to Japan. It is reported that chestnut oak bark and extract are not exported in significant amounts.

IMPORTS.

Bark.—In 1914, 256,078 pounds of "chestnut bark," valued at $4,234, were imported into the United States. In 1916, 458 pounds, valued at $21, and in 1917, 120 pounds, valued at $15, were imported.

Extract.—In 1913–14 fiscal year, 217,048 pounds of oak extract, valued at $8,832, were imported into the United States.[1]

In 1914, 143,094 pounds of oak bark extract valued at $6,539 were imported; in 1915, 65,293 pounds, valued at $2,628 were imported.

PRICES.

(*a*) *California tanbark oak.*—Prices on California tan oak bark reported by harvesters and tanners show considerable divergence. Bark in 1912 was $15 to $21 per cord; in 1914, $14.50 to $22; 1916, $14.50 to $23; 1918, $23.50 to $30; and in 1920, $27.75 to $38 per cord.

Tan oak bark extract 32° sold in 1912 and 1914 for 6 cents per pound; in 1916, for 7 cents; in 1918 and 1920, for 10 cents per pound f. o. b. San Francisco.

(*b*) *Chestnut oak.*—Oak bark (white)[2] is quoted from April, 1912, to April, 1918, at 3 to 5 cents per pound, from July, 1918, to April, 1919, at 4 to 5 cents per pound. In the latter part of 1919 and for January, 1920, it was quoted at 6 to 8 cents per pound.

Oak extract (25 per cent tannin) is quoted in January, 1912. at 3 to 3½ cents per pound; from October, 1912, to April, 1916, at 8 to 8½ cents per pound, receding in 1916 to 6 to 8 cents per pound. In 1917 it was quoted at 4 to 4½ cents, in 1918 it varied from 3½ to 5 cents, and in 1919 from 4¼ to 5¾ cents. In January, 1920, it was quoted at 5¼ to 5¾ cents per pound.

TARIFF HISTORY.

Oak bark is not specifically mentioned; it has been included on the free list since the act of 1883.

Oak extract is mentioned in the act of 1913 on the free list. By the acts of 1909 and 1897 it was dutiable at the rate of seven-eighths of 1 cent per pound. By the act of 1894 it was dutiable at the rate of 10 per centum ad valorem, and by the act of 1890 at seven-eighths of 1 cent per pound.

COMPETITIVE CONDITIONS.

Oak bark and oak extract have not been subjected to serious competition by the importations of these products.

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[1] Chemicals and Allied Products Used in the United States. Miscellaneous Series 82, Department of Commerce.

[2] This refers to the chestnut oak bark; oak bark quotations (red) refers to the black oak used for quercitron dye manufacture.

TARIFF CONSIDERATIONS.

The domestic supply and the annual cut of oak bark are decreasing. The domestic supply is not sufficient to meet the requirements of the tanners. The use of imported tanning materials in conjunction with oak tends to conserve the domestic supply of oak bark. Unlimited importation of quebracho, mangrove, and other foreign tanning materials of low cost and high tannin content would decrease the price of oak bark. A high tariff on imported tanning materials would increase the price of oak bark and hasten the exhaustion of the domestic supply of this tanning material.

Oak bark extract—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1914	Free	143,094	$6,539	$0.046
1915	do	65,293	2,628	.040

Oak and chestnut extracts—Production in United States.

	Quantity.	Value.
	Pounds.	
1899	28,983,036	$529,670
1904	156,520,123	2,411,184
1909	266,529,514	4,321,637
1914	328,197,524	4,130,042

Oak bark, white—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	.....	3–5	3–5	3–5	3–5	3–5	3–5	4–5	6–8
April	3–5	3–5	3–5	3–5	3–5	3–5	3–5	4–5	.....
July	3–5	3–5	3–5	3–5	3–5	3–5	4–5	6–8	.....
October	3–5	3–5	3–5	3–5	3–5	3–5	4–5	6–8	.....

Oak extract—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	3–3½	8–8½	8–8½	8–8½	8–8½	4–4½	4–4½	4½–5	5½–5¾
April	3–3½	8–8½	8–8½	8–8½	8–8½	4–4½	3½–4½	4½–5	.....
July	3–3½	8–8½	8–8½	8–8½	6–8	4–4½	3½–4½	5–5½	.....
October	8–8½	8–8½	8–8½	8–8½	6–8	4–4½	4½–5	[1] 5½–5¾	.....

[1] 25 per cent tannin.

TARIFF RATES.

OAK BARK.

Act of 1913—Paragraph 624, * * * and other barks * * * and articles in a crude state used in dyeing or tanning, free.
Act of 1909—Paragraph 499, articles in a crude state used in dyeing or tanning, not specially provided for in this section, free.
Act of 1897—Paragraph 482, articles in a crude state used in dyeing or tanning, not specially provided for in this act, free.
Act of 1894—Paragraph 386, articles in a crude state used in dyeing or tanning, not specially provided for in this act, free.
Act of 1890—Paragraph 492, articles in a crude state used in dyeing and tanning, not specially provided for in this act, free.

OAK EXTRACT.

Act of 1913—Paragraph 624, * * * extracts of oak * * *, free.
Act of 1909—Paragraph 22, * * * extracts of bark, such as commonly used for dyeing or tanning, not specially provided for in this section, seven-eighths of 1 cent per pound.
Act of 1897—Paragraph 22, * * * extracts of barks, such as are commonly used for dyeing or tanning, not specially provided for in this act * * *, seven-eighths of 1 cent per pound.
Act of 1894—Paragraph 18, * * * and extracts of barks * * *, 10 per centum ad valorem.
Act of 1890—Paragraph 26, * * * and extracts of barks * * *, not specially provided for in this act, seven-eighths of 1 cent per pound.

QUEBRACHO AND QUEBRACHO EXTRACT.

SUMMARY.

Quebracho occurs commercially in two forms, as quebracho logs and quebracho extract (liquid and solid) for tanning. It is considered the world's most important tanning asset. The quebracho tree is a natural monopoly of South America. The forests of Argentina and Paraguay are estimated to contain 168,000,000 tons of wood.

The United States is one of the world's largest consumers of quebracho extract. It is used for tanning sole, upper, heavy leathers, and calf and sheepskins, nearly always in combination with other tanning extracts, as chestnut, hemlock, oak, etc.

The manufacture of quebracho extract is highly developed and conducted on a large scale in South America. In 1912–1914 93 per cent of our imported extract came from Argentina; in 1916–17 our total imports came from South America. The Forestal Land, Timber & Railway Co. produces the bulk of extract made in Argentina and Paraguay. A pool agreement exists between a group of extract makers of those two countries for fixing the production and price of extract. Quebracho logs are not controlled by the pool. The extract maker of South America, located in the forest, enjoys a large economy of freight on raw material and has cheaper labor than the domestic manufacturer. The war tended to centralize extract manufacture in South America through the embargo on logs and scarcity of tonnage.

In the United States one concern, a branch of the Forestal Land, Timber & Railway Co., manufactured quebracho extract during 1920. Another plant had ceased production in December, 1918, and the plant of a third producer was destroyed by fire. The imports of

extract for the period 1907–1917 were nearly twice the domestic production of extract. One former manufacturer of quebracho extract reported in 1920 that the manufacture of extract in the United States was at that time unprofitable.

Imported quebracho extract is competitive with the domestic-made quebracho extract and other tanning materials, as chestnut, hemlock, oak.

The cessation of extract manufacture in the United States with removal of competition to South American producers makes it possible for the South American producer to dictate the price of extract for the United States.

Quebracho logs have always been duty free. The extract, by the act of 1913, was placed on the free list. By the act of 1909 the duty on extracts of quebracho not exceeding in density 28° Baumé was one-half of 1 cent per pound; extracts exceeding in density 28° Baumé, three-quarters of 1 cent per pound. By the act of 1897, extracts of quebracho were dutiable at one-half of 1 cent per pound. The extract imports are now restricted to the solid extract.

General Information.

Paragraph 624, act of 1913.—"Tanning materials: Extracts of quebracho, * * *; and articles in a crude state, used in dyeing or tanning; all the foregoing not containing alcohol and not specially provided for in this section, free."

DESCRIPTION.

Wood.—Quebracho is a South American wood used largely in the manufacture of tanning extract. Commercially it occurs in two forms, as quebracho logs and as a solid or liquid extract made by hot-water extraction of the chipped wood. The quebracho tree is a natural monopoly of South America and is considered the most important tanning material of the world.

At one time, the term "quebracho" (from the Portuguese "quebrar," break, and "hacha," ax) was applied to most of the South American hard trees; the indefinite use of this term has caused much confusion. To-day it commercially includes three trees, the white, the red, and the true quebracho. The true quebracho, the chief source of the tannage, is botanically known as the *Quebrachia lorentzii*, or Loxopteryngium. It belongs to the family of the Awacardiaceae, or Cashew family, and to the genus Quebrachia growing in Argentina, Bolivia, Brazil, Paraguay, and Uruguay.

The quebracho tree under favorable conditions reaches a height of 50 to 75 feet, varying in diameter from 2 to 4 feet. The average tree varies from 18 to 36 feet in height and 18 to 40 inches in diameter. The best quality of wood is the first growth on the Parana River and the Picole Majo River.

In freshly cut trees, the sapwood is light yellow in color, gradually turning pale red on exposure. The heart wood is dark red in color, turning darker with age. The wood is a very dense, hard, fine-grained wood, with a specific gravity of 1.27 to 1.38; a cubic foot weighs about 78 pounds. Even the green wood requires highly

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tempered steel for cutting and working. It is one of the hardest known woods. As the wood takes a high polish, it is valued as a cabinet wood and in house construction, a part of the best quality logs being used for this purpose.

It has also considerable application for railroad ties; although these lack resilience and crack when exposed to frost, they remain almost indefinitely in a perfect state of preservation due to their high tannin content. Ties layed 25 years were found to be perfectly sound. These ties cost $2 to $2.50 each; nine of the Argentina ties (9 feet by 10 inches by 13 inches) weigh a ton. It has been found that a tie will yield over $10 worth of extract, accordingly the extract market is the preferred market for wood. During the war, on account of coal shortage in South America, quebracho wood was used as fuel.

Quebracho wood contains 15 to 25 per cent tannin, although certain samples have run as high as 28 per cent. The distribution of the tannin in the tree is as follows: Heartwood, 20 to 24 per cent; sapwood, 3 to 4 per cent; bark, 6 to 8 per cent. Only the tannin of the heartwood is at present utilized.

The tannin of quebracho is sparingly soluble in water. Its exact chemical character is not settled; on account of the low solubility of quebracho tannin, it is subjected to a chemical treatment to increase the solubility. The pure tannin has been prepared free from phlobophones. It forms a light, flaky, hydroscopic mass. It was considered identical with the tannin of maletto and cinchona bark. It is stated that catechol and phloroglucinol nuclei are present and also a red phlobophone. In addition, quebracho contains a yellow coloring matter identical with fisetin found in young fustic wood.

Extract.—Quebracho extracts are marketed as a black, brittle solid of 65 per cent tannin content (untreated, and chemically treated to increase solubility) and as a liquid extract of 35 per cent and 25 per cent tannin content, respectively. The solid extract is shipped in bags and casks, while the liquid is shipped in barrels and tank cars.

USES.

Quebracho extract is used in tanning sole, upper, heavy leathers, as strapping and belting, calf and sheepskins. In 1914 it constituted 87 per cent of the imported tanning materials and 38 per cent of the total domestic tanning materials consumed. It acts quickly and thoroughly, giving a leather of good strength, toughness, and firm feel, and produces a more mellow leather than bark tannage, forming a good grain in a shorter time. Quebracho is seldom used alone, as best results are given by combining it with other tannages, as chestnut, oak bark, hemlock, or mangrove.

The combination with chestnut is of great importance and extensively used. One reason for using quebracho in combination with extracts is the low content of fermentable nontannin matter, which produce acid on fermentation. The absence of these fermentable nontannins makes quebracho a "sweet" or "nonplumping" tannage. It has a greater percentage of tannin to a given density than any other important tannage.

It is used as a substitute for the more expensive gambier and produces a fine grain soft texture, and the necessary pliability for preparation of patent leather.

FOREIGN PRODUCTION.

Raw materials.—The quebracho tree, as previously stated, is a natural monopoly of South America. It is commercially exploited on a large scale in northern Argentina and the Province of Chaco, in Paraguay. The quebracho growth covers about 300,000 square miles and the center is known as "El Gran Chaco," in northern Argentina and western Paraguay. This tree occurs in a scattering growth, seldom more than five trees to the acre, thus making cutting operations very costly. About 500,000 acres of wood are cut over each year, yielding about 1,000,000 tons of wood. The tree is of very slow growth, the annual cut is estimated to be greater than the annual growth, and the total supply is estimated at 168,000,000 tons. Recent estimates indicate that at the present rate of consumption the known supply of quebracho logs will last over 100 years. The value of the land varies from $2 per acre, when near the railroads, to 15 to 25 cents per acre. The average in Paraguay is reported to be $1.50 per acre.

Method of production.—The quebracho logs are reduced to small chips or sawdust by revolving cylinders containing knives; any resulting coarse material is sifted out and reduced to proper size by a disintegrator. According to early practice, the chips were extracted by hot water in open vats. As exhaustion of the wood was incomplete, this equipment has been displaced by closed copper extractors with the use of direct steam.

Liquors of a strength of 20° Baumé and upward are obtained. These are cooled and allowed to stand until the insoluble matter has settled. Light and air is excluded to prevent darkening and oxidation of the extract. Clarification and decolorization are carried out with a variety of substances, including blood, alum, nitrate of lead, sulphurous acid, etc. By treatment with sulphites of alkali metals, sulphides, and other chemicals, the insoluble tannins are dissolved and precipitation is prevented in the sour tan liquors. The bulk of the South American made extract is given a sulphite treatment. This prevents the formation of an insoluble slimy film on the leather, and enables ready penetration of the tannin. The decolorized or untreated extract is then evaporated in triple effect vacuum evaporators to a liquid of 35 per cent tannin content, or to a point where 20 to 25 per cent water remains. This product, on cooling, solidifies and contains 65 per cent tannin. According to Argentine practice, 91 to 93 per cent of the tannin in wood is removed. The tannin content of the heartwood is 15 to 25 per cent, averaging 21 per cent.

Organization.—The extract industry is highly organized and well developed, and was able during the war to meet the large demand for extract. The largest producer of extract, the La Forestal Land, Timber & Railway Co., controls over 6,000,000 acres of land, owns its railroads, barges, tugs, and has extract plants situated in or near the forests. It had an authorized capital of $15,695,000 and produces the bulk of extract of Argentina and Paraguay. Several other companies produce quebracho extract, and there are many independent cutters of logs.

Previous to the war German capital and equipment were represented in South America. During the war change of ownership took place. Controlling interest of the La Forestal is now held by the British. The other companies are now mostly controlled by Argentine capital.

To limit production and fix the price a syndicate was formed in 1907. Owing to lack of agreement the pool was dissolved in 1909. It was reformed in 1916. The effect of the pool on selling prices of extract is discussed under the paragraph dealing with prices.

History of Quebracho.—Early explorers report the use of quebracho wood as a tannage by the Paraguayan natives. This wood first appeared at the Paris exposition in 1867. In 1871 quebracho was used by several tanneries in Havre and Antwerp and, in 1876, by the Swiss and the German tanners on the Rhine. As an important tanning material its use dates back about 30 years.

Although the logs, on account of their great weight, are difficult to handle, they were shipped to Europe and the United States, where the extract was made by the tanners or extract makers. The use of quebracho was an important factor in the development of the German tanneries and enabled Germany to displace American tanned leather, as indicated by the following data. In 1876 United States exported 6,400,000 pounds of leather to Germany; in 1886, 2,000,000 pounds; and in 1906, our export to Germany was only 205,000 pounds.

Previous to 1889 South America engaged only in cutting and exporting the logs; in that year the first extract plant was established on the Paraguay River. Since that date a rapid development of the extract industry has taken place, and at present there are about 20 extract plants in South America.

The early use of extract was restricted on account of the large amount of insoluble tannin. The discovery by Dr. Lepetit and Tagliani, of Milan, that by treatment of quebracho extract with sulphites of alkali metals the insoluble tannins were dissolved and precipitation prevented in the sour tan liquors was of fundamental importance to the widespread use of quebracho. Patents for this process were taken out in all European countries in 1896. The United States patent was not granted, however, until 1905. Under this patent large-scale production of extract was developed in Berlin, and Germany became a large exporter of this product.

England, Germany, Italy, and the United States manufactured extract previous to the war, and also during the war, with the exception of Germany.

Foreign production and exports.—Argentina and Paraguay are the largest producers of extract. Ninety-odd per cent of the South American extract is exported. England, Germany, and Italy previous to the war made and exported considerable quantities of extract. The total possible world's output is estimated to be about 200,000 tons. Argentina exported in 1895 quebracho extract valued at $40,167, increasing with slight fluctuations to an export of $909,904 in 1902. The value of the exports varied from $1,204,041 in 1903 to $4,226,333 in 1909. In 1910–1915 the value of the exports varied from four to five millions per year. Due to the enormous demand for military leather in Europe and the United States this export value increased to $15,873,372 in 1915, reaching the maximum export of $19,663,098 in 1916. In 1918 the export of extract was valued at $13,190,090. In 1913 quebracho logs and extract constituted 2 per cent of the total value of exports shipped from Argentina. In 1916 the same products constituted 40 per cent of the total value of exports.

Before the war Germany exported over 20,000 metric tons of extract per year during the period 1911–1913. It is stated that on account of the scarcity of returning freights quebracho logs go to Liverpool at a lower rate than from the River Plate to New York. This has favored the importation of logs to England and the preparation of extract in that country, resulting in an export trade in extract. Italy has also produced considerable quantities of extract.

In spite of the economy of freight in favor of the extract the export of logs has shown a rise proportional to the increase in extract production in South America up to the year 1915; after that date the extract exports increased enormously, while the export of logs decreased.

During the war, to economize tonnage, the United States prohibited the importation of quebracho logs. The restriction announcement was made April 22, 1918, by the War Trade Board. One ton of quebracho wood occupies 65 cubic feet, or 1.3 ship tons, while 1 ton of solid extract occupies 42 cubic feet, or 0.84 ton. In addition to the freight economy on account of bulk, a greater advantage in favor of the extract is its higher tannin content. The extract contains 65 per cent tannin, while the logs contain about 20 per cent; hence a ton of extract (2,200 pound) contains 1,300 pounds of tannin, while a ton of logs (2,200 pounds) contains 400 pounds of tannin. One ton of solid extract requires about 3½ tons of logs. This economy in freight is an important factor in the development of extract production in South America and favors the importation into the United States of solid rather than liquid extract. In addition, the high or low freight rates have influenced the export of extract from Argentina.

The estimated production of 1919 in South America [1] was a minimum of 144,650 tons of extract and a maximum of 204,500 tons, divided as follows:

		Low.	High.
La Forestal	tons..	122,150	174,000
Fontana (Ltd.)	do....	10,000	12,000
International Product	do....	2,500	5,000
All other	do....	10,000	13,000

The tendency of the war was to centralize the world's production of quebracho extract in South America.

The Argentina export duty on quebracho logs was 0.000487 per pound and 0.00535 per pound on extract in April, 1920. The export duty of Paraguay in April, 1920, was 0.000218 per pound on logs and 0.0035 on extract.

DOMESTIC PRODUCTION.

Materials.—The quebracho log is the raw material of the quebracho extract industry. The export of logs from South America is not under the control of the syndicate, as there are many independent concerns cutting and selling quebracho logs. The price, however, of the independent cutters is influenced by the syndicate quotation on logs. The equipment for the manufacture of extract is available in the United States. The method and equipment used is similar to that described under foreign production.

[1] Commerce Reports, No. 133, June 7, 1919.

Organization.—Three firms were formerly manufacturing quebracho extract from the logs: The New York Quebracho Co., Brooklyn, N. Y.; Stamford Extract Manufacturing Co., Stamford, Conn.; and Elk Tanning Extract Co., Ridgway, Pa. The first of these firms, the largest producer, is owned by the Forestal Land, Timber & Railway Co., of Argentina, and was the only plant making extract in 1920. The Stamford extract plant, also a manufacturer of dyewood extracts, was destroyed by fire. The Elk Tanning Extract Co. is owned by the Central Leather Co., one of the largest tanning and leather concerns in the United States. One of the former makers reports that the high cost of ocean freights, insurance, and shipping costs make the domestic manufacture of extract unprofitable in competition with the South American product. The manufacture of extract requires technical men, and the investment is several thousand dollars per barrel per day output of extract.

In addition to the preparation of extract from logs, it is estimated that about 25 per cent of the imported solid extract is dissolved and sold to the tanner as a liquid extract. This liquid may be given a clarification and precipitation treatment.

Domestic production and consumption.—Our production of extract has not been adequate to meet the domestic consumption. The United States has imported both extract and logs. The imported extract has from one to five times the value of the imported logs. Liquid extract made from wood is lighter in color, contains less "reds," more nontannin, and brings a higher price than liquid extract made by dissolving solid extracts. Tanners claim that certain advantages accrue from its use. This favors a production, on a limited scale, of extract in the United States from imported logs. The quebracho extract production is not separately listed in the census of manufacturers.

Assuming that 1 ton of solid extract requires on the average 3½ tons of wood, the production of extract in the United States, based on the imported logs, has been as follows: For the period 1907–1915 the average yearly production in terms of solid extract was 44,904,200 pounds. During this period 81,757,714 pounds was the average yearly import. In the period 1914–1917 the average yearly production in terms of solid extract was 48,400,000 pounds; during that period the average yearly import of extract was 87,567,492 pounds. The quantity of extract imported is nearly twice the domestic production.

Domestic exports.—The United States does not produce quebracho extract in sufficient quantity to meet the domestic demands. The export trade is restricted to the reexportation of foreign-made solid extract. Small amounts of domestic-made liquid extract have been exported to Canada, which is the chief consumer of the reexported foreign-made extract.

IMPORTS.

Argentina is the chief source of our quebracho extract. In the period 1912–1914, 93 per cent of our imported extract came from that country; 3.3 per cent from England; and 1.6 per cent from Italy. In 1916–17 our total imports came from South America.

In 1907, 76,034,000 pounds of extract, valued at $2,320,000, were imported, increasing to 102,005,000 pounds in 1909 valued at

$2,741,000, and gradually receding to 67,281,000 pounds in 1912 valued at $2,223,000, and again increasing to the maximum import of 120,450,283 pounds, valued at $3,676,749, in 1915. Imports decreased from this point to 59,808,734 pounds, valued at $5,198,904, in 1917.

PRICES.

The price of quebracho extract has been subject to great variation, owing to syndicate control or lack of syndicate control, with subsequent overproduction, and to variation in demand for this tanning material and to the recent high war freight rates.

Solid quebracho extract in the period January, 1912, to July, 1915, is quoted at 4¾ to 5¼ cents per pound, increasing abruptly to 12 to 13 cents per pound in the latter part of 1915. In January, 1916, it reached the maximum price of 20 cents per pound. During the latter part of 1916 and 1917 it was quoted at 14 to 16 cents per pound, receding to 9 to 11 cents in 1918. In 1919 it increased to 13 to 15 cents per pound and was quoted at 11½ to 13 cents per pound in January, 1920.

Liquid quebracho extract of 42° was quoted at 2⅞ to 3 cents per pound in 1912–1915. In 1916 it sold for its maximum price of 14 cents, receding to 5½ cents per pound in 1918. Liquid extract of 51° was quoted at 3½ to 4 cents per pound during the period January, 1912, to October, 1915, increasing to 15 cents in January, 1916, and later receding to 6½ to 7 cents in the latter part of 1918. In January, 1920, it was quoted at 5½ to 6 cents per pound. Liquid extracts made from wood command ½ to 1 cent more per pound than the liquid extract made by dissolving the solid extract.

The average price per ton on quebracho extract for Argentine export for the year 1914 was $56.64; for 1915, $138.64; for 1916, $176.38; for 1917, $136.30; for 1918, $89.28 and $99.39. The average annual price on quebracho logs per ton for the same years are as follows: 1914, $11.33; 1915, $11.20; 1916, $12.56; 1917, $13.30, and 1918, $14.62.

The invoice value of the United States imports of extract in 1914 was $54 per ton; for 1915, $58; for 1916, $134; for 1917, $174, and for 1918, $96. The above values are the yearly average for both liquid and solid quebracho extract.

In 1907 the panic forced large sales of quebracho extract, resulting in a demoralized market for quebracho and other tannins as well. At the time of the formation of the syndicate solid quebracho extract sold for $57.90 to $77.20. The syndicate first raised the price of extract to $67.55 per ton, and later to $72.38 per ton. In 1909 the syndicate dissolved, due to the lack of agreement, and the price dropped; reaching in 1913 $59.83 per ton. This figure is reported to be only slightly above the actual production cost of solid extract in Paraguay. Many factories shut down and the Argentine producers complained that Germany made and sold extract from imported logs for less than the Paraguay cost of production. The frontier value declared by German exporters was $55.70 to $58.75 per ton. The advent of the war increased the demand for extract and removed German competition. In the early part of 1915 solid quebracho extract was quoted at $77.20 per ton. The war demands caused a rapid increase to $220 per ton in

the early part of 1916, the price reaching a maximum of $236.42 per ton in the second quarter of 1916. At this price overproduction occurred and the substitution of cheaper tanning materials in Europe caused the price to recede. According to a report published November 24, 1916, in La Nacion, in Buenos Aires, 10 companies, 6 Argentinian and 4 Paraguayan, with an annual production of 165,000 tons of extract, formed a syndicate to reduce the output to meet the world's consumption, estimated at 130,000 tons, and to fix a uniform price. A Buenos Aires firm was selected as the sole buyer and seller.

After the syndicate agreement the price of extract rose to $144.75 per ton. In January and February, 1917, the price was $173.70, later being reduced to $164.05 per ton. This figure held through April and May. Later, in spite of the pool formation, the price, on account of high freight and decreased demand, receded in the early part of 1919 to about $96 per ton. By April, 1919, it returned to $135 per ton for export and $111 per ton for domestic consumption.

TARIFF HISTORY.

Quebracho logs have been duty free. Quebracho extract by the act of 1913 was free. By the act of 1909 the extract was dutiable, those extracts not exceeding in density 28° Baumé at the rate of one-half of 1 cent per pound, while those exceeding 28° Baumé were at the rate of three-fourths of 1 cent per pound.

The effect of the 1909 act was to favor the importation of solid extract. At the time of the act of 1897 the only grade of extract imported was the liquid extract of about 28° Baumé, containing about 35 per cent tannin. Between 1897 and 1907, the manufacture of solid extract was perfected. The 1909 rate of one-half of 1 cent per pound duty on the extract not exceeding 28° Baumé and three-fourths of 1 cent per pound on those over 28° Baumé includes the solid extract of 65 per cent tannin under the latter class. These rates are not in proportion to the tannin content or the value of the two extracts. They favor the solid extract and resulted in the importation of solid quebracho extract. In addition, the solid extract can be shipped in bags, which cost less and reduce the freight cost. The solid extract also involves shipping less water and more tannin than the liquid. By the act of 1897 extracts of quebracho were dutiable at one-half of 1 cent per pound. The first mention of quebracho distinct from other tanning extracts was made in 1897.

COMPETITIVE CONDITIONS.

The South American extract plant situated in the interior enjoys a large economy of freight in contrast to the American extract maker, who must pay freight on logs from the forest to New York. The tannin content of the logs is 21 per cent and the solid extract 65 per cent. The cost of labor is much less in South America than in the United States. The domestic producer has the advantage of better skilled help and technical control. The German quebracho extract makers are reported, owing to their greater skill, to have sold at the German ports, prior to the war, extracts made from imported logs, at a lower price than the cost figured without profits on extract delivered

at Buenos Aires. England has also been an exporter of quebracho extract. The British extract maker has a lower freight on logs to England than the American to New York, owing to the lack of cargoes from the River Plate to England for returning ships. The bulk of extract made in South America is under the control of the syndicate, but the supply of logs is not under their control.

Tariff Considerations.

South American quebracho extract is competitive not only with domestic quebracho extract, but with the domestic tanning materials, chestnut, hemlock, oak, etc. Chestnut is the most important domestic tanning material, and is produced in a quantity adequate for the domestic requirements. The domestic peel and the supply of hemlock and oak, on the other hand, is decreasing. Importations of quebracho have a direct influence on the amount of chestnut and other domestic tannins manufactured and consumed. Overproduction of quebracho extract affects the price and production of the world's other important tanning materials.

The cost of quebracho is an important factor in the cost of tanning certain grades of leather. Increases in cost may be due to the tariff rates or to the South American extract pool, which has power to determine the export price from that country.

The tariff of 1909, with a duty of one-half of 1 cent per pound on extracts not exceeding 28° Baumé density, three-fourths of 1 cent per pound on extracts above 28° Baumé density, resulted in importation of the solid extract (65 per cent tannin) practically eliminating the liquid extract (35 per cent tannin) from our imports. The solid extract (65 per cent tannin) is to-day the important extract of commerce, as this contains more tannin, less water, and can be shipped at less cost and in cheaper containers, bags being used in place of tight barrels required for the liquid extract.

A tariff on the solid quebracho extract would favor the domestic production of liquid extract from imported logs.

The manufacture of quebracho extract in the United States primarily depends on whether logs can be imported at a cost which will permit of their manufacture into extract in competition with extract from South America. The higher value and better properties of liquid extract made from wood compared with liquid extract made from solid extract favors the production of extract on a limited scale in the United States. This holds true only where the price differential is not too great. It is stated that elimination of the American quebracho extract manufacturer would, by failure of competition offered to the South American extract industry, give the foreign pool control of the quebracho extract prices and enable the foreign producer to subject the American tanner to exorbitant rates.

Quebracho extract—Imports by countries (fiscal years).

[War Trade Board, Bureau of Research.]

Imported from—	1912	1913	1914	3-year average, 1912–1914.	1915	1916	1917
Europe:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Austria-Hungary	1,984	22,046	.....	8,010	.....	.....	.....
Belgium	.....	56,967	319,243	125,403	.....	.....	.....
France	5,086	160,511	.....	55,199	500	.....	.....
Germany	250,072	180,853	160,709	197,211	220	.....	.....
Italy	1,573,550	1,462,371	1,065,541	1,367,154	398,505	.....	.....
Netherlands	.....	.....	.....	.....	220	.....	.....
United Kingdom—							
England	2,522,528	2,372,729	3,195,014	2,696,757	1,759,861	.....	.....
Scotland	.....	33,010	.....	11,003	.....	.....	.....
North America:							
Canada	.....	.....	.....	.....	5,512	.....	.....
Mexico	600	.....	.....	200	.....	.....	.....
South America:							
Argentina	66,568,310	74,004,852	88,588,580	76,387,247	118,285,465	81,501,952	59,806,474
Brazil	.....	.....	.....	.....	.....	.....	2,260
Chile	161,249	.....	.....	53,750	.....	.....	.....
Uruguay	551,664	540,127	.....	363,930	.....	.....	.....
Total	71,635,043	78,833,466	93,329,087	81,265,865	120,450,283	81,501,952	59,808,734

Quebracho (extracts for tanning)—Imports by countries (fiscal years).

Imported from—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Argentina	87,530,515	$2,796,288	85,720,722	$2,893,888	66,568,310	$2,194,876
England	1,321,004	31,239	3,322,175	69,783	2,522,528	55,607
Italy	2,504,154	59,944	2,718,524	59,814	1,573,550	34,507
Germany	2,010,867	70,181	167,328	3,994	250,072	6,489
Belgium	1,673,918	59,004	153	5	.....	.....
All other	142,615	5,246	110,351	3,315	720,583	28,557
Total	95,183,073	3,021,902	92,039,253	3,030,799	71,635,043	2,320,036

Imported from—	1913 (dutiable).		1914 [1]		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Argentina	74,004,852	$1,895,736	88,588,580	$2,441,083	118,285,465	$3,624,632
England	2,372,729	52,491	3,195,014	68,463	1,759,861	41,351
Italy	1,462,371	35,156	1,065,541	23,377	398,505	10,369
Germany	180,853	4,414	160,709	3,351	220	19
Belgium	56,967	1,270	319,243	7,028	.....	.....
All other	755,694	16,703	.....	.....	6,232	378
Total	78,833,466	2,005,770	93,329,087	2,543,302	120,450,283	3,676,749

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Argentina	81,501,952	$5,432,468	59,806,474	$5,198,667	95,582,775	$4,660,250
England	.....	.....	.....	.....	.....	.....
Italy	.....	.....	.....	.....	.....	.....
Germany	.....	.....	.....	.....	.....	.....
Belgium	.....	.....	.....	.....	.....	.....
Uruguay	.....	.....	.....	.....	5,940,507	256,962
All other	.....	.....	2,260	237	.....	.....
Total	81,501,952	5,432,468	59,808,734	5,198,904	101,523,282	4,917,212

[1] Includes, dutiable, 20,411,304 pounds ($550,407): 19,627,570 pounds ($532,651), from Argentina; England, 467,606 pounds ($10,426); Italy, 259,977 pounds ($6,037); Belgium, 56,151 pounds ($1 293).

Quebracho wood—Imports for consumption—Revenue.

Fiscal years.	Rate of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Tons.				*Per cent.*
1908	Free	48,871	$612,971		$12.54	
1909	do	66,093	731,795		11.07	
1910	do	80,210	1,058,647		13.20	
1911	do	64,703	952,726		14.72	
1912	do	68,174	982,315		14.41	
1913	do	101,869	1,300,126		12.76	
1914	do	73,957	900,880		12.18	
1915	do	54,715	750,873		13.72	
1916	do	106,864	1,598,465		14.96	
1917	do	95,211	1,086,946		11.42	
1918	do	53,871	848,671		15.75	
1919	do	2,689	31,048		11.55	
1920	do	33,672	480,503		14.27	

Quebracho, extracts for tanning—Imports for consumption—Revenue.

Fiscal year.	Rates of duty	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	½ cent per pound	62,593,671	$2,037,648	$312,968	$0.033	15.36
1909	do	99,108,284	2,685,021	495,541	.027	18.46
1914	Free	91,792,517	2,495,629		.027	
1915	do	125,565,857	3,676,749		.029	
1916	do	81,501,892	5,432,458		.067	
1917	do	61,977,849	5,382,433		.087	
1918	do	101,523,282	4,917,212		.048	
1919	do	137,151,143	5,856,803		.043	
1920	do	154,944,717	8,023,641		.052	
EXCEEDING IN DENSITY 28° BAUMÉ.						
1910	¾ cent per pound	55,982,266	$1,879,507	$419,867	$0.034	22.34
1911	do	74,304,509	2,545,587	557,283	.034	21.87
1912	do	70,660,665	2,359,906	529,955	.033	22.46
1913	do	60,967,429	1,609,592	457,255	.026	28.41
1914	do	7,222,681	189,653	54,170	.026	28.56
NOT EXCEEDING IN DENSITY 28° BAUMÉ.						
1910	½ cent per pound	34,501,310	$978,411	$172,506	$0.028	17.63
1911	do	3,302,191	72,757	16,510	.022	22.69
1912	do	3,579,050	82,987	17,895	.023	21.56
1913	do	2,637,385	62,722	13,186	.024	21.02
1914	do	590,641	13,822	2,953	.023	21.37

Quebracho extract—Exports of foreign merchandise (fiscal years).

Exported to—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	109,884	$3,670				
United Kingdom	321,865	11,135			154,867	$4,518
Canada	5,519,366	161,974	5,575,264	$156,898	4,152,807	120,580
Mexico	15,478	535	52,979	1,735	45,625	1,678
Cuba	129,596	3,859	60,652	1,704		
Japan			715,021	23,815	531,127	17,800
All other	1,030	22	2,173	80	16,337	605
Total	6,097,219	181,195	6,406,089	184,232	4,909,902	145,315

Quebracho extract—Exports of foreign merchandise (fiscal years)—Continued.

Exported to—	1913		1914[1]		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	432,767	$10,872				
United Kingdom	111,858	3,118				
Canada	4,954,130	121,942	4,109,193	113,233	317,972	$9,403
Mexico	157,842	4,076	32,136	1,446		
Cuba	21,665	697	32,638	798		
Japan	169,974	5,052	32,249	1,212	123,911	4,936
Denmark					43,127	1,500
Italy					160,382	5,069
Switzerland					155,190	4,942
Russia in Asia					278,108	11,806
All other	8,825	228	5,514	143	74,049	2,860
Total	5,857,061	145,985	4,211,730	116,832	1,152,739	40,516

Exported to—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Netherlands	134,545	$8,703	575,961	$38,100		
Sweden	1,039,805	109,893	434,622	68,965		
Canada	500,991	51,912	2,258,916	166,562	1,388,350	$91,787
China			32,856	3,460		
Japan	434,113	44,979	925,324	81,686		
Denmark	112,293	13,422				
Russia in Asia	54,036	5,054				
New Zealand	50,321	2,242				
Australia	250,177	11,146				
All other	64,035	5,020				
Total	2,640,316	252,371	4,227,679	358,773	1,388,350	91,787

[1] Free and dutiable.

Quebracho, solid—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	4½–5½	4½–5½	4½–5¼	4½–5½	20	14–16	9 –11	9½–10	11½–13
April	4½–5½	4½–5½	4½–5¼	4½–5½	14–16	14–16	9 –11	9½–10	11½–13
July	4½–5½	4½–5½	4½–5¼	4½–5½	14–16	14–16	9½–9½	10½–11	10½–11
October	4½–5½	4½–5½	4½–5¼	12 –13	14–16	14–16	(1)	13 –15	10 –11

[1] Nominal.

Quebracho, liquid, 42°—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	2⅞–3	2⅞–3	2⅞–3	2⅞–3	14	6½	5½	(1)	.....
April	2⅞–3	2⅞–3	2⅞–3	2⅞–3	14	6½	5½	.....	.....
July	2⅞–3	2⅞–3	2⅞–3	2⅞–3	9	6½	.....	.....	.....
October	2⅞–3	2⅞–3	2⅞–3	5–6	6½	6½	.....	.....	.....

[1] Nominal.

Quebracho, liquid, 51°—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	3½–4	3½–4	3½–4	3½–4	15	7–8	7–8	[1] 7–8 (2)	[1] 5½–6
April	3½–4	3½–4	3½–4	3½–4	14	7–8	7–8	[1] 5½–6¼	[1] 5½–6
July	3½–4	3½–4	3½–4	3½–4	10	7–8	[1] 6¼–7	[1] 6–6½	[1] 6–6¼
October	3½–4	3½–4	3½–4	6–7	7–8	7–8	(2)	[1] 6–6½	[1] 5¾–6¼

[1] 35 per cent tannin. [2] Nominal.

Quebracho and quebracho extract—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	22	* * * Extracts of quebracho and of hemlock bark	½ of 1 cent per pound.
1909	22	* * * Extracts of quebracho, not exceeding in density 28° Baumé.	Do.
		Exceeding in density 28° Baumé	¾ of 1 cent per pound.
1913	624	Tanning material: Extracts of quebracho, and of hemlock bark; extract of nuts and nutgalls and woods used expressly for dyeing or tanning: * * * all the foregoing not containing alcohol and not specially provided for in this section.	Free.

Crude wood—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1894	386	Articles in a crude state used in dyeing or tanning, not specially provided for in this act.	Free.
1897	482	....do	Do.
1909	499	Articles in a crude state used in dyeing or tanning, not specially provided for in this section.	Do.
1913	624	Tanning material: * * * and articles in a crude state used in dyeing or tanning: all the foregoing not containing alcohol and not specially provided for in this section.	Do.

Quebracho—Export duties.

ARGENTINA.

	Logs.	Extract.
	Cents per pound.	*Cents per pound.*
1918.		
March	0.0000648	0.00201
April	.0000648	.00131
May	.0000648	.00131
June	.0000520	.00131
July	.0000520	.00131
August	.0000520	.00131
September	.0000520	.00131
October	.0000520	.00131
November	.0000520	.00131
December	.0000520	.00131
1919.		
January	.0000520	.00131
February	.0000520	.00131
March	.0000520	.00131
April	.0000914	.00221
May	.0000914	.00282
June	.0000914	.00326
July	.000392	.00354
August	.000392	.00392
September	.000392	.00470
October	.000238	.00540
November	.000238	.00540
December	.000238	.00540
1920.		
January	.000270	.00577
February	.000389	.00578
March	.000449	.00559
April	.000487	.00535

Quebracho—Export duties—Continued.

PARAGUAY.

	Cents per pound.
Logs.	
January, 1913, to April, 1920	0.000219
Extract.	
Previous to Jan. 1, 1916	0.000438
Jan. 1, 1916, to February, 1918	.004376
February, 1918, to February, 1919	.002188
February, 1919, to Aug. 16, 1919	.001313
Aug. 16, 1919, to September, 1919	.002188
September, 1919, to April, 1920	.003501

SUMAC.

General Information.

Act of 1913.—Paragraph 30, "Extracts and decoctions of * * * sumac, * * * three-eighths of 1 cent per pound." Paragraph 618, "Sumac, ground or unground, free."

DESCRIPTION.

Sumac consists of the dried leaves and leaf stems of several species of the Rhus. The *Rhus coriaria* is extensively cultivated in Sicily, giving the best and least-colored sumac. The Venetian and Turkish sumac, of poorer quality, is furnished by the *Rhus cotinus*. Italy, Spain, Greece, and the United States are large producers of sumac. In Europe the *Pistacia lentiscus* (mastic tree), "schinia" or "skins," is used for the adulteration of the true sumac. Large amounts are exported from-Tunis to Sicily for this purpose.

The domestic sumac is derived chiefly from the *Rhus glabra* (white), *Rhus copallina* (dwarf), and the *Rhus hirta* (staghorn). Virginia, West Virginia, North Carolina, Maryland, and Pennsylvania furnish the domestic supply of leaf. The supply in the United States is extremely large. Recently, sumac intermediate in quality between the Sicily and the Virginia leaf has been found in Kentucky and Tennessee.

Sumac is sold as whole leaves with twigs, in bags or bales, and as "ground sumac." The latter product results from the grinding of the leaf. The extract is marketed as a thick red-brown liquid of 42° and 51° Twaddell, containing 22 to 23 per cent and 26 to 27 per cent tannin, respectively. The domestic leaf, properly gathered and cured, contains about 20 to 22 per cent tannin. Sumac from the red clay soils of Powhatan and Amelia Counties of Virginia contains over 30 per cent tannin. The sumac tannin is ordinary gallotannic acid.

Imported Sicilian sumac consists entirely of the cured leaf. It has a lower color content than the domestic leaf, which is probably due to several factors: (1) Sicily sumac is cultivated; (2) the soil and climatic conditions differ from those in the United States; (3) great care is taken in curing; and (4) the species of sumac is not the same as the domestic.

USES.

Most of the domestic sumac extracts are consumed by the textile industry for the dyeing and printing of cotton, where it serves as a mordant for "basic" dyes. It is also used on silk as a mordant and a weighting agent. Sumac is used in tanning pigskins, sheepskins, and light leather used for bookbinding, gloves, hatbands, etc., and for removing dark-colored tans from the surface of bag, case, and harness goods. Most of the Sicilian extracts are used in tanning the light-colored leathers. In the textile trade it has the same uses as the domestic extract, possessing the advantage of less color.

DOMESTIC PRODUCTION.

Gathering and curing sumac leaf.—As already stated, the domestic supply is very large. It occurs east of the Mississippi, growing wild, not only without cultivation but even as a nuisance, in cut-over, uncultivated, and mountainous districts. It is gathered on a large but unorganized scale in Virginia, West Virginia, Maryland, Pennsylvania, and North Carolina. Excepting in Virginia, all three varieties, the white, dwarf, and staghorn, are mixed. In eastern Virginia the white, or *Rhus glabra*, is gathered exclusively; Buckingham and Albemarle Counties give the best quality leaf.

The extract manufacturer recognizes two varieties of sumac, the "white leaf" and "dark leaf," the latter giving a higher yield of extract.

Usually the sumac is scattered, although occasionally large dense patches are found. In gathering, the branches are cut or broken below the lowest leaf. The roots and stems are of no value to the extractor. The average amount gathered by a man is 200 to 300 pounds per day on the dry basis. Women and children gather a considerable part of the crop. It is allowed to wilt and dry in the sun, or is spread directly in 1 to 3 foot layers in a barn where it slowly drys, being frequently turned to prevent mildewing. There is a 50 to 60 per cent loss of weight in curing, and an additional 5 to 15 per cent loss in transfer and packing. It is packed in bags furnished by the manufacturer for shipment. A small part is baled; this entails a loss of leaf. The prewar price received by the farmer was $0.60 to $1.10 per hundredweight, but the price has not been as high in recent years. For the 1920 crop the price has advanced to $2 per hundred pounds.

The improvement of the domestic sumac leaf by offering a bonus on the better grades has been suggested. It is doubtful whether the farmer would accept the decisions of the extract manufacturer on the quality of the leaf, and the establishment of a Government bureau might be necessary in order to develop successfully a bonus system.

Equipment and method of production of sumac extract.—The dried sumac broken leaf is extracted by hot water in a series of copper autoclaves arranged as a diffusion battery, either in single units or units of three. The resulting thin extract passes through filter tanks for removing suspended leaf or fiber and is evaporated under reduced pressure in a triple-effect vacuum evaporator to a density of 42° or 51° Twaddell; it is then run into barrels for shipment. This equipment is obtainable in the United States. Extract made in America

from imported Sicilian leaf is reported superior to the European manufactured product.

Decolorized extracts are made by treating the dilute extracts before evaporation with blood albumin, sulphurous acid, and a variety of chemical agents, filtering and evaporating to required density. This renders the extract available for use in dyeing and tanning for lighter shades.

The Virginia domestic leaf yields about 60 per cent by weight of 51° Twaddell extract, the Sicilian leaf yields about 65 per cent of the 51° Twaddell extracts.

The extraction can be carried out advantageously in small factories located near the sumac supply or the baled sumac can be shipped to a factory where other dye or tanning extracts are made.

Geographical distribution.—The gathering, curing, and manufacture of extract is conducted in Pennsylvania, Maryland, Virginia, and West Virginia.

Domestic production and consumption.—The United States in 1914 produced 4,512,361 pounds of sumac extract, valued at $129,631. (Census of Manufactures.) This extract was made from both domestic and imported Sicilian leaf. The imports of sumac extract in the same year were 1,463,297 pounds. Information submitted to the Tariff Commission, in reply to a questionnaire, indicates that the domestic production in 1918 of sumac extract (terms of 51° Twaddell density) was 5,254,208 pounds. The domestic production of sumac extract in 1909 was 3,148,790 pounds, valued at $107,456; in 1904, 4,093,619 pounds were produced, valued at $95,958.

The imports of sumac extract were 32 per cent of the domestic production in 1914. As previously stated, the large demand for the Sicilian product is due to the superior color of the foreign leaf.

Domestic exports.—Excepting to Canada, the United States does not export any considerable amounts of sumac extract. During the war small amounts were exported to England, South America, and Japan.

FOREIGN PRODUCTION AND IMPORTS.

Italy is the largest producer of sumac. Large exports are made from Italy to Great Britain, France, Switzerland, United States, and other countries. Cultivation of sumac is highly developed in Italy, and the Sicilian leaf is the best quality produced.

The exports of ground sumac from Italy have decreased from 49,000,000 pounds in 1912 to about 24,000,000 pounds in 1918. The Italian exports of unground sumac also decreased about 50 per cent during this period, or from 22,000,000 pounds in 1912 to about 9,000,000 pounds in 1918. The principal consuming countries of Italian exports of sumac have been the United Kingdom, the United States, and France.

The imports of ground or unground sumac in the period 1909 to 1914 varied from 10,976, 481 pounds, valued at $291,562 in 1909 to 14,112,112 pounds, valued at $289,255 in 1913. The maximum import consisted of 20,411,022 pounds, valued at $527,102 in 1916. The 1917–18 imports were approximately one-half those of 1916. In 1919, 4,128,309 pounds were imported, valued at $145,286. In the period 1910–1914, over 97 per cent of the imports of sumac, ground or unground, leaf came from Italy.

The sumac extract imports in the period 1910–1914 varied from 987,348 pounds, valued at $36,025 in 1911, to 1,463,297 pounds, valued at $59,022 in 1914. During the war the imports of extract showed a great decrease, amounting to 23,706 pounds, valued at $2,616 in 1918. Over 97 per cent of the imported sumac is of Sicilian origin. The remaining 3 per cent was imported from England, Belgium, Mexico, and the British Straits Settlements.

PRICES.

Domestic ground sumac was quoted at $41 per ton in January, 1915, $36 per ton in January, 1916, and $50 per ton in January, 1917. In 1918 it varied from $55 to $70 per ton, increasing to $80 to $85 per ton in 1919.

The imported Sicilian sumac (28 per cent tannin) sold in the period 1912 to 1917 for $52 to $76 per ton, excepting the last quarter of 1914, when it is quoted at $100 per ton. In 1917 and 1918 it increased to $100 per ton, reaching $140 per ton in April, 1919. In 1920, January, it was quoted at $105 to $110 per ton. The stainless Sicilian sumac extract in the period 1912 to July, 1914, was quoted at 3 to 6½ cents per pound, increasing to 10 to 17 cents in January, 1916, receding to 5 to 13½ cents per pound in the later half of 1917. In 1918 it was quoted at 10 to 11 cents in the first three quarters, increasing to 14 to 15 cents for 1920.

Domestic extract 51° Twaddell, was quoted at 5½ to 6½ cents per pound in January, 1918, 6½ to 8 cents in January, 1919, and 7½ to 8 in January, 1920.

Extract makers had the same difficulties to combat in the importation of sumac and its extract as they did with dyestuffs and tanning materials. Lack of shipping space and shortage of labor, especially in Italy, on account of the war kept the prices high and materials very scarce.

TARIFF HISTORY.

Ground sumac was dutiable by the act of 1890 at four-tenths of 1 cent per pound. In 1897 this was reduced to three-tenths of 1 cent per pound. By the act of 1913 sumac, ground or unground, was placed on the free list.

Sumac extract was dutiable by the act of 1890 at seven-eighths of 1 cent per pound; this was reduced to five-eighths of 1 cent per pound by the act of 1897, and again reduced by the act of 1913 to three-eighths of 1 cent per pound.

With the exception of the year 1916, when the ground sumac imported was nearly double the normal import, imports in the period 1914–1919, when the ground sumac was free, are not greater than the imports for the period 1909–1914, when imported ground sumac was subject to a duty of three-tenths of 1 cent. The imports of sumac extract during the period 1910–1915, under duty of five-eighths of 1 cent per pound, were greater than those of the period 1915–1919, when the rate of duty was three-eighths of 1 cent per pound. It should be noted in this connection that the imports during the war period were subject to influence by war conditions, including the scarcity of vessels.

COMPETITIVE CONDITIONS.

The cultivation of sumac in Sicily is highly developed. Sicily is the world's largest producer, and the quality of Sicilian sumac leaf is the best. The imported leaf has commanded a higher price than the domestic leaf, due to its lower color content, rendering this product available for purposes for which the domestic product is not adapted. The imported sumac could be used for most purposes for which the domestic is consumed. For certain special applications, however, extract made from domestic leaf is better adapted than the extract made from imported leaf. The domestic product on account of its reddish color is restricted in application to certain kinds of dyeing and tanning, and is used because of its lower cost. Information is not at hand concerning the actual cost of leaf in Sicily. It has not been quoted in the United States at a price as low as that of the domestic.

Because of the difference in quality between Sicilian and domestic sumac leaf, the two products are not directly competitive. Each is used for a particular purpose. So long as this difference in quality in favor of Sicilian sumac exists, it is likely that it will be imported regardless of tariff duties. Sicilian extract has been consistently quoted at New York at a price about double that of the domestic extracts.

Sumac, extract and ground, for tanning—Production in United States ("Official source").

[From Federal Census of Manufactures, Table 101.]

SUMAC EXTRACT.

Year.	Quantity.	Value.
	Pounds.	
1899	4,349,742	$103,085
1904	4,093,619	95,958
1909	3,148,790	107,456
1914	4,512,361	129,631
GROUND SUMAC.		
1899	9,284,000	$114,600
1904	5,061,333	65,190
1909	554,032	24,531

Sumac, ground or unground—Imports by countries, by fiscal years.

Imported from—	1913 [1]		1914 [2]		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Italy	14,370,349	$294,618	10,599,070	$256,095	13,164,538	$323,416
England			129,738	1,601		
Scotland	5,078	229				
Belgium	30,000	653				
British Straits Settlements			33,600	912		
Mexico	84,349	2,006				
All other			7,992	130	644	32
Total	14,489,776	297,506	10,770,400	258,738	13,165,182	323,448

[1] Dutiable.

[2] $1,121,762 pounds dutiable; 9,648,638 pounds free.

Sumac, ground or unground—Imports by countries, by fiscal years—Continued.

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Italy	21,541,466	$555,239	11,637,023	$365,173	14,032,926	$466,561
England					13,280	1,084
Scotland						
Belgium						
British Straits Settlements						
Mexico						
All other	924	37			456	18
Total	21,542,390	555,276	11,637,023	365,173	14,046,662	467,663

Sumac, ground—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	1/10 cent per pound.	10,976,481	$291,562	$32,929	$0.027	11.29
1910	do	12,605,164	280,404	37,815	.022	13.49
1911	do	11,571,708	215,298	34,715	.019	16.12
1912	do	12,642,129	238,587	37,926	.018	15.88
1913	do	14,112,112	289,255	42,336	.020	14.64
1914	do	851,473	15,299	2,554	.017	16.70
1914	Free	8,827,246	216,281		.024	
1915	do	12,048,917	294,434		.023	
1916	do	20,411,022	527,102		.025	
1917	do	10,877,008	337,404		.031	
1918	do	10,557,920	355,192		.033	
1919	do	4,128,309	145,286		.035	

Sumac, extract, for dyeing—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	1/8 cent per pound.	1,461,373	$54,899	$9,133.60	$0.038	16.64
1911	do	987,348	36,025	6,170.91	.036	17.13
1912	do	1,389,733	46,551	8,685.85	.033	18.66
1913	do	1,270,825	44,568	7,942.65	.035	17.82
1914	do	433,505	16,049	2,709.40	.037	16.88
1914	3/8 cent per pound.	1,029,792	42,973	3,861.72	.042	8.99
1915	do	727,449	35,066	2,727.95	.048	7.78
1916	do	36,003	4,108	135.01	.114	3.29
1917	do	161,507	13,944	605.66	.086	4.34
1918	do	23,706	2,616	88.90	.110	3.78
1919						

Sumac, unground—Exports, from Italy, by fiscal years.

Exported to—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	8,130,564	$128,121	8,237,929	$173,084	2,800,944	$58,850
Great Britain	1,424,613	22,449	885,367	18,602	1,076,947	22,627
United States	637,791	10,050	573,196	12,043	1,330,697	27,959
Switzerland	23,369	368	13,228	278	236,995	4,979
Other countries	11,950,475	188,315	8,410,108	176,702	5,739,676	120,594
Total	22,166,812	349,303	18,119,828	380,709	11,185,259	235,009

Exported to—	1915		1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	6,035,313	$126,806	5,574,772	.....	2,453,499	.....	1,312,839	.....
Great Britain	2,048,294	43,036	1,836,211	.....	444,006	.....	494,051	.....
United States	1,295,864	27,227	3,084,235	.....	5,793,689	.....	5,448,669	.....
Switzerland	1,135,148	23,850	4,364,447	.....	2,216,726	.....	1,962,976	.....
Other countries	1,993,620	41,887	2,205	.....	.....	.....	.....	.....
Total	12,508,239	262,806	14,861,870	455,375	10,907,920	620,701	9,218,535	524,569

Sumac, ground—Exports from Italy, by fiscal years.

Exported to—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	7,574,344	$132,618	5,443,378	$119,134	2,798,740	$61,253
Great Britain and Ireland	21,891,458	383,294	13,799,253	302,011	12,112,072	265,085
United States	11,601,267	203,125	8,469,632	185,367	11,938,791	261,293
Other countries	7,530,692	131,854	6,471,824	141,643	5,391,349	117,995
Total	48,597,761	850,891	34,184,087	748,155	32,240,952	705,626

Exported to—	1915		1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	4,613,126	$100,963	4,461,008	.....	6,082,712	.....	4,114,665	.....
Great Britain and Ireland	12,363,397	270,586	10,819,074	.....	11,123,971	.....	12,363,397	.....
United States	14,530,738	318,021	13,302,777	.....	8,129,242	.....	6,689,197	.....
Other countries	3,022,066	66,141	1,050,492	.....	762,130	.....	1,048,287	.....
Total	34,529,327	755,711	29,633,351	$985,807	26,098,055	$1,599,314	24,215,546	$1,483,952

Sumac and sumac extract, prices wholesale, spot, New York markets.

[From Oil, Paint, and Drug Reporter.]

Fiscal year.	Sumac (per ton).		Sumac extract (cents per pound).		
	Domestic.	Sicilian.[1]	Domestic.[2]		Sicilian stainless.[2]
			42°	51°	
1912—January		$55.00			3 - 6½
April		$53.00- 55.00			3 - 6½
July		52.00- 54.00			3 - 6½
October		65.00			3 - 6½
1913—January		67.50- 70.00			3 - 6½
April		69.00- 70.00			3 - 6½
July		69.00- 70.00			3 - 6½
October		65.00- 70.00			3 - 6½
1914—January		65.00- 70.00			3 - 6½
April		65.00- 70.00			3 - 6½
July		62.00			3 - 6½
October		100.00			3¾- 6½
1915—January	$41.00-$16.00	64.00- 65.00			3¾- 6½
April		65.00- 67.00			3¾- 6½
July		65.00			3¾- 6½
October		65.00- 68.00			6 - 6½
1916—January	38.00	60.00			10 -17½
April		76.00			10 -18
July		75.00			9 -16
October		68.00			7 -13½
1917—January	50.00	80.00- 90.00			7 -13½
April		90.00			7 -13½
July		85.00- 88.00			5 -13½
October		87.00- 90.00			5 -13½
1918—January	60.00	95.00-100.00	4½	5½-6½	10 -11
April	55.00- 58.00	95.00- 98.00	4½-5	5½-6½	10 -11
July	60.00- 62.00	98.00-100.00	4½-5	6 -7	10 -11
October	70.00	95.00-125.00	4½-5	5½-6½	11 -12
1919—January	85.00- 90.00	125.00-130.00	Nominal.	6½-8	Nominal.
April	Nominal.	115.00-145.00	Nominal.	6½-8	Nominal.
July	80.00- 85.00	110.00-120.00	5½-6	6½-8	15 -16
October	80.00- 85.00	105.00-110.00	6 -7	7 -8	14 -15
1920—January	80.00- 85.00	105.00-110.00	6½-7	7½-8	14 -15
April	77.00- 82.00	90.00- 95.00	7¼-7½	8 -8½	15 -15½
July	70.00- 75.00	80.00- 85.00	7½-8	8½-9	15 -15½
October	70.00- 75.00	80.00- 85.00	7½-8	8½-9	15 -15½

[1] Listed as Sicily No. 1, or "28 per cent tannin." Not quoted prior to 1918.

[2] Listed "Sumac."

Sumac, domestic, ground—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
January				$41–46	$38	$50	$60	$85–90	$80–85
April							55–58	([2])	77–82
July							60–62	80–85	70–75
October						([1])	70	80–85	70–75

[1] Not given.

[2] Nominal.

Sumac extract, domestic, 51°—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1918[1]	1919	1920
	Cents.	*Cents.*	*Cents.*
January	5½–6½	6½–8	7½–8
April	5½–6½	6½–8	8 –8½
July	6 –7	6½–8	8½–9
October	5½–6½	7 –8	7½–8

[1] Not quoted prior to 1918.

Sumac extract, stainless, Sicilian, prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912 [1]	1913	1914	1915 [1]	1916 [1]	1917 [1]	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	3–6½	3–6½	3 –6½	3½–6½	10–17½	7–13½	10–11	([2])	14–15
April	3–6½	3–6½	3 –6½	3½–6½	10–18	7–13½	10–11	([2])	15–15½
July	3–6½	3–6½	3 –6½	3½–6½	9–16	5–13½	10–11	15–16	15–15½
October	3–6½	3–6½	3½–6½	6 –6½	7–13½	5–13½	11–12	14–15	15–15½

[1] Listed "sumac." [2] Nominal.

Sumac, Sicily, prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	$55	$67.50–$70.00	$65–$70	$64–$65	$60	$80–$90	$95–$100	$125–$130	$105–$110
April	$53– 55	69.00– 70.00	65– 70	65– 67	76	90	93– 98	115– 145	90– 95
July	52– 54	69.00– 70.00	62	65	75	85– 88	98– 100	110– 120	80– 85
October	65	65.00– 70.00	100	65– 68	68	87– 90	95– 125	105– 110	80– 85

Sumac—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	11	Sumac, ground	$\frac{1}{10}$ of 1 cent per pound.
		Sumac extract	20 per centum ad valorem.
1890	26	* * * extract of sumac * * *	$\frac{7}{8}$ of 1 cent per pound.
	89	Sumac, ground	$\frac{4}{10}$ of 1 cent per pound.
1897	85	.....do	$\frac{3}{10}$ of 1 cent per pound.
	22	* * * Extracts of sumac * * *	$\frac{5}{8}$ of 1 cent per pound.
1909	82	Sumac, ground	$\frac{1}{10}$ of 1 cent per pound.
	22	* * * Extract of sumac * * *	$\frac{5}{8}$ of 1 cent per pound.
1913	618	Sumac, ground or unground	Free.
	30	Extracts and decoctions of * * * sumac * * *	$\frac{3}{8}$ of 1 cent per pound.

COURT AND TREASURY DECISIONS.

Ground sumac, adulterated with 15 per cent of lentisco, was held to be exempt from duty because commercially known as ground sumac. (Abstract 165, T. D. 24973, of 1904.)

VALONIA.

GENERAL INFORMATION.

Act of 1913.—Paragraph 639, "Valonia, free."

DESCRIPTION.

Valonia, a valuable tanning material, consists of the acorn cups of certain species of oak, chiefly *Quercus aegilops*, sometimes called the valonia oak, and probably *Quercus macrolepsis*, *Quercus graeca*, *Quercus ungeri*, and *Quercus coccifera*. The *Quercus aegilops* is found in the highlands of Morea, Roumelia, the Greek Archipelago, Palestine, and Asia Minor. The *Quercus macrolepsis* is abundantly occurrent in Greece, especially in the lower slopes of Taygetos. In Algeria the valonia oak is used for reforestation on acccunt of its good adoption and rapid growth. The tree is cultivated along the shores. Smyrna, Greece, and Asia Minor export large quantities of valonia.

In Asia Minor the acorns ripen in July or August. They are shaken from the trees, allowed to dry on the ground, and later piled in heaps 5 and 6 feet high, where for several weeks a fermentation takes place. The acorns contract and separate from the cups. In case this fermentation proceeds beyond a certain point, a dark color develops, injuring the product. The cups are sorted, the finest are sent to Trieste, and the other grades are exported. As the acorns are of low tannin content, they are used for feeding hogs. In Greece, the best quality (chamada) is gathered before the acorns are ripe, in about April; a second quality is gathered in September or October (rhabdisto); and a third inferior variety (charcola) is of little value. The total valonia harvest is reported as 50,000 to 60,000 tons per year. The largest known crop is stated at 70,000 tons in Asia Minor and 14,000 in Greece. The best quality of Turkey valonia exported from Smyrna does not reach this country. A large amount of lower quality Greek valonia is sent to the United States.

The good quality cups are of light drab color and are covered with a coarse hair, known as beard, which is very rich in tannin. A yellow coloring matter is also present. The content of tannin is about 36 per cent for Smyrna valonia, and the beards up to 45 per cent; Greek valonia up to 32 per cent, beards up to 40 per cent, and about 40 per cent for Candia valonia. The Smyrna valonia deposits more bloom and is lighter in color than the Greek. The dark-colored cups have been injured by dampness and overfermentation and are of inferior value. The Greek and Smyrna cups are marketed in the United States and the beards usually contain 10 per cent more tannin than the cups.

The tannin somewhat resembles that of oak wood but gives a brown color and a heavier bloom on leather. It consists of a mixture of a gallotannin and an ellagitannin. In practice it combines the qualities of the pyrogallol and catechol tannin.

The extract is prepared by hot-water treatment of valonia cups or beard and subsequent evaporation under reduced pressure. The extract is marketed as a liquid of 25 per cent tannin and a solid extract of 65 per cent tannin.

Uses.—Valonia is used for tanning high-grade leathers of light color. It gives a heavy-weight leather of firm texture and deposits a high amount of bloom. Valonia is adapted for sole leather and is used with gambier and other materials for dressing leather.

Alone, valonia gives a brittle leather. It is ordinarily used in combination with such tanning materials as oak bark, myrobalans, or mimosa bark.

Extract.—Practically all of the imported valonia beards are leached directly by the tanner. There are no firms reported as producers of valonia extract for sale in this country. The imported extract averages 60 per cent tannin content. There are two factories owned by English syndicates operating near Smyrna, Asia Minor.

Imports.—In 1912, 1,196,591 pounds of valonia were imported, valued at $24,680. In 1914, 7,654,055 pounds were imported, valued at $116,406. The import quantity is not separately given for years outside of the period 1912–1915. The import of maximum value was $207,088, in 1911. The imports for the latter part of the war ceased on account of the shipping scarcity. In 1914, 69 per cent of the import came from Asiatic Turkey, 30 per cent from European Turkey, 0.4 of 1 per cent from England, and 2 per cent from Greece.

Domestic production.—Valonia cups, beards, and extract are of foreign origin. The imported beards are used directly by the tanners. No extract production is reported in the United States.

TARIFF CONSIDERATIONS.

Valonia beards and extract are indirectly competitive with domestic tanning materials. The properties of valonia differ somewhat from our domestic tanning materials. Large importations tend to reduce the price and quantity consumed of domestic tanning materials.

Valonia—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	Free		$122,319			
1911	do		207,088			
1912	do	1,196,591	24,680		$0.021	
1913	do	5,295,762	79,610		.014	
1914	do	7,654,056	116,406		.015	
1915	do	6,352,190	88,061		.013	
1916						
1917						
1918						

Extracts for tanning, not containing alcohol—Valonia and myrobolans—Imports for consumption—Revenue.

Calendar year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1918	Free	831,923	$19,070		$0.024	
1919	do	2,221,201	53,221		.023	

Valonia[1]*—Prices per ton.*

[From Oil, Paint, and Drug Reporter.]

	Cups (30 per cent).	Beards (40 per cent).
July, 1920	$48-$53	$70 $75

[1] Not quoted prior to July, 1920.

Tariff history, valonia—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	639	Valonia	Free.
1909	705	.....do	Do.
1897	693	.....do	Do.
1894	665	.....do	Do.
1890	748	.....do	Do.

COURT AND TREASURY DECISIONS.

The merchandise is clearly established by the record to be an extract made from the cup of the acorn of the valonia oak. Paragraph 624 of the act of 1913 was evidently intended to be all-embracing. While it may be said that the cup of an acorn of an oak tree is not in a highly technical sense the bark or the wood of the oak tree, for the purposes of the tariff law it must be so considered. (Abstract 37219, of 1915.)

Under the act of 1897 such merchandise, then designated as valonea extract, was classified with quebracho and hemlock bark and accordingly dutiable by similitude under paragraph 22 at the rate of one-half cent per pound. (Abstract 21122, T. D. 29715, of 1909.)

NATURAL DYES.

ANNATTO.

General Information.

Act of 1913, paragraph 399: Annatto * * * and all extracts of, free.

Description.—Annatto, a natural orange-yellow dye, is prepared from the seed shells of the shrub *Bixia arellana*, a native of Central America, East and West Indies, India and Guiana. It is cultivated in South America, East and West Indies, India, and Guiana. This color appears on the market as a reddish-yellow paste of buttery consistency and in the form of rolls or dry cakes.

The important coloring constituent, bixin, is a red crystalline compound slightly soluble in water and more soluble in alcohol and chloroform than in the ordinary organic solvents. It dissolves in sulphuric acid with a characteristic blue color. A soluble yellow coloring matter called orrelline, probably an oxidation product of bixin, is also present. A product was formerly marketed under the name of "bixin" of 5 to 6 times the strength of commercial annatto for the textile trade.

Annatto is partially soluble in water and more soluble in alcohol and alkaline solutions. With alumina it forms an orange lake and with tin a lemon-yellow lake. It has been adulterated with tumeric and other coloring matter, also gum, starch, and different mineral substances.

Uses.—Annatto is used as a coloring matter for oils, butter, cheese, and margarine. As it is very sensitive to the action of light, it is no longer used in the textile industry.

Preparation of annatto.—It is a hardy, shrubby tree growing best in a warm climate with good rainfall. The war-like caribs of the Lesser Antilles and Guiana used roucou as a war paint. The propagation is carried out by seeds; the seedlings are set out and yield full crops in three to four years, although seeds may be gathered in 18 months. The first full crop will amount to about 500 pounds of seed per acre. The fruit is a miter-shaped capsule splitting into halves containing 30 to 40 seeds; these are gathered when ripe.

The seeds are covered with a waxy substance, containing the coloring matter. By one method annatto is prepared by treating the seeds with boiling water and allowing the resulting liquid to ferment. After the color settles it is air-dried to a putty consistency and formed into rolls wrapped in banana leaves weighing 2 to 3 pounds; this is known as roll annatto. The drying may be continued and the product is formed into 8 to 10 pound cakes. In Guadaloupe a crude product is made by allowing to ferment for about two weeks. the mass obtained by macerating the shell pulp and seeds with water, After passing this mass through a sieve the coloring matter settles and is evaporated in large iron pans to a thick paste. The final

drying is carried out by the sun. The color content is from 3 to 12 per cent and the physical characteristics vary according to their source. The fresh product has a carrot-like odor and not infrequently has an ammoniacal odor from the fermentation process and formerly from the addition of urine for the purpose of giving a brighter color.

Imports.—The imports for consumption before the war varied from 405,024 pounds in 1913, valued at $19,991, to 936,163 pounds in 1912, valued at $34,921. In the war period the maximum import was 809,903 pounds, valued at $53,174 in 1915. In 1918 the imports were 749,782 pounds, valued at $73,194.

Prices.—The prewar price for annatto seed was 7–7½ cents per pound. During the war this increased to 17–18 cents per pound in the second quarter, 1916. This price receded to 5½–6 cents a pound in last quarter of 1919. The prewar price on "annatto fine" was 32–35 cents per pound. This increased to 45–60 cents per pound in 1916–17, gradually receding to 32–33 cents in 1919.

Tariff history.—Annatto "and all extracts of" have specifically been shown on the free list since 1883.

Annatto, roucou, or orleans, and all extracts of—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate
Fiscal year—		*Pounds.*				
1909	Free	711,191	$48,329		$0.068	
1910	do	619,372	39,579		.064	
1911	do	632,742	30,445		.048	
1912	do	933,163	34,921		.037	
1913	do	405,024	19,991		.049	
1914	do	507,250	25,341		.050	
1915	do	809,903	53,174		.066	
1916	do	603,271	69,811		.116	
1917	do	669,445	78,017		.117	
1918	do	749,782	73,194		.098	
1919	do	205,059	12,549		.061	
Calendar year—						
1918	do	655,250	62,961		.096	
1919	do	356,432	19,972		.056	
1920 [1]	do	759,117	31,002		.041	

[1] First six months.

Annatto—Wholesale, per pound, New York.

[From Oil, Paint. and Drug Reporter.]

FINE.

Months.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	32–35	32–35	32–35	40–60	40–60	45–60	33–35	32–33	32–33
April	32–35	32–35	32–35	40–60	45–60	45–60	33–35	32–33	32–33
July	32–35	32–35	32–35	40–60	45–60	45–60	30–32	32–33	.....
October	32–35	32–35	40–60	40–60	45–60	45–60	33–34	32–33	.....

SEED.

January	7–7½	7–7½	7– 7½	10–14	8– 8½	15–16	11	8½–11	5½–6
April	7–7½	7–7½	7– 7½	8– 8½	17–18	16–17	11 –11½	8½– 9½	4½–5
July	7–7½	7–7½	7– 7½	8– 8½	15–16	16–17	9 –11	6 – 6½	.....
October	7–7½	7–7½	10–14	8– 8½	15–16	16–17	8½–11	5½– 6	.....

Annatto—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	[1] 2503	Annatto * * * and all extracts of	Free.
1894	375	.....do	Do.
1897	475	.....do	Do.
1909	494	.....do	Do.
1913	399	.....do	Do.

[1] Section.

ARCHIL AND CUDBEAR.

General Information.

Act of 1913, paragraph 469: Cudbear, free.

Act of 1913, paragraph 564: Orchil or orchil liquid, free.

Description.—Archil and cudbear are purple dyes prepared from certain lichens, their use extending back to ancient times. The lichens are of wide occurrence. The most important varieties used as a source of the dye are the *Roccella tinctoria* or Valparaiso weed, the *Rocella fuciformia* or Lima weed, and the *Ochrolechia tartacea* of Sweden and Norway.

The lichens contain colorless phenols as orcin, which by a process of oxidation in alkaline solution give the coloring matter. The chief coloring matter is orcein, a brown amorphous mass (dihydroxy-methylbenzene), somewhat soluble in water and readily soluble in alcohol and alkalis.

Uses.—Archil and cudbear are used for bluish reds on wool (chiefly carpet yarns), silk, and feathers, with or without a mordant, and also in dyeing compound shades. During the war they were used on ladies' woolen dress goods. Although fugitive these shades are of good depth and body. Archil and cudbear are not used on cotton. Formerly they were used as a wine color. The faster coal-tar dyes are now displacing archil and cudbear.

Preparation.—The preparation is carried out by treating the finely shredded lichens, in a cylinder containing stirrers, with dilute ammonia for several days. The access of air is under control and the temperature elevated to 35°–60° C. This operation gives "archil paste," 20 to 35 per cent, known also as persis. Blue archil is the first product; continued action produces red archil. After removing the extracted lichens it is sold as "archil liquor," with a strength of 8° to 20° Tw. By drying and grinding archil paste prepared from *Lecanora tartarea*, a purple powder results known as "cudbear."

French purple is manufactured by first treating the lichens with dilute ammonia solution. The coloring matter is precipitated by hydrochloric acid; after washing it is dissolved in concentrate ammonia and kept at a temperature of 160° F. for about three weeks. After a purple color is developed, calcium chloride is added to form a purple color lake. In dyeing, this is applied with oxalic acid.

Imports.—In the period 1910–1915 the yearly value of imported archil or orchil liquid varied from $21,569 to $42,559. In 1916 the value of the import was $114,603. This decreased to $55,712 in 1918.

In the period 1909–1915 the minimum import of cudbear was 19,929 pounds, valued at $1,155 in 1912; the maximum import was 35,863 pounds, valued at $2,130 in 1910. In 1916 and 1918 the imports were 55,948 and 362,504 pounds, respectively, valued at $6,512 and $10,166.

Prices.—The prewar price of "archil concentrated" was 14–15 cents per pound. This reached a maximum in 1916 of 55 cents per pound, gradually receding to 25–30 cents in 1918.

"Archil double" sold at 8–10 cents per pound in 1912–13. In 1916 it reached 50 cents a pound, receding to 15–18 cents per pound in January, 1920.

Tariff history.—Archil or orchil liquid and cudbear have been specifically shown on the free list since 1883.

The uses, sources, method of preparation of archil or archil liquid and cudbear are similar and these products should be included in same tariff paragraph.

In the tariff the old spelling "orchil" is used; this should be changed in accordance with the modern usage, "archil."

Archil or archil liquid—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				
1910	Free		$38,769			
1911	do		42,559			
1912	do		34,653			
1913	do		27,386			
1914	do		21,569			
1915	do		37,802			
1916	do		114,603			
1917	do		98,905			
1918	do		55,712			
1919	do	[1] 259 124	30,351		$0.117	
Calendar year—						
1918	do		56,284			
1919	do	372,606	42,085		.112	
1920 [2]	do	345,801	30,207		.087	

[1] Not previously shown. [2] First six months.

Cudbear—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				
1909	Free	34,865	$2,104		$0.060	
1910	do	35,863	2,130		.059	
1911	do	25,880	1,859		.072	
1912	do	19,929	1,155		.058	
1913	do	27,971	1,755		.063	
1914	do	15,653	1,061		.068	
1915	do	24,827	1,680		.068	
1916	do	55,948	6,512		.116	
1917	do	47,163	6,105		.129	
1918	do	62,504	10,166		.162	
1919	do	44,432	6,012		.135	
Calendar year—						
1918	do	54,447	9,411		.173	
1919	do	33,391	4,150		.124	
1920 [1]	do	17,924	2,842		.149	

[1] First six months

Archil—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

CONCENTRATED.

Months.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	14–15	14–15	14–15	15–17	50–55	45	30	25–30	25–30
April	14–15	14–15	14–15	15–17	55	45	30	25–30	(1)
July	14–15	14–15	14–15	17–19	55	45	25–30	25–30	34–40
October	14–15	14–15	15–17	50–55	45	45	25–30	25–30	33–35

DOUBLE.

January	8–10	8–10	8–10	10–12	44–45	25	16–18	16–18	15–18
April	8–10	8–10	8–10	10–12	50	25	16–18	16–18	(1)
July	8–10	8–10	8–10	14–15	50	25	16–18	16–18	30–35
October	8–10	8–10	10–12	40–45	35	25	16–18	16–18	25–27

[1] Nominal.

Cudbear—Prices wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

FRENCH.

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	12–15	12–15	12–15	25–30	25–30	70–80	70–80	(1)	.....
April	12–15	12–14	12–15	25–30	70–80	70–80	70–80	.....	.....
July	12–15	12–15	12–15	25–30	70–80	70–80	(1)	.....	.....
October	12–15	12–15	25–30	25–30	70–80	70–80	.....	.....	.....

ENGLISH.

January	7¾–10	7¾–10	7¾–10	15–20	15–20	18–20	30–32	[2] 30–40	[2] 21–25
April	7¾–10	7¾–10	7¾–10	15–20	70–80	18–20	30–32	[2] 30–40	[2] 21–25
July	7¾–10	7¾–10	7¾–10	15–20	70–80	30–32	(1)	[2] 30–40	[2] 24–27
October	7¾–10	7¾–10	15–20	15–20	20–25	30–32	30–40	[2] 30–40	[2] 24–27

CONCENTRATED.

January	23–28	23–28	23–28	40–50	40–50	75–85	75–85	(1)	.....
April	23–28	23–28	23–28	40–50	75–85	75–85	75–85	.....	.....
July	23–28	23–28	23–28	40–50	75–85	75–85	(1)	.....	.....
October	23–28	23–28	40–50	40–50	75–85	75–85	.....	.....	.....

[1] Nominal. [2] No. 1, 200-pound blocks.

Archil, or orchil liquid—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	550	Orchil, or orchil liquid	Free.
1890	665	.....do	Do.
1894	571	.....do	Do.
1897	628	.....do	Do.
1909	642	.....do	Do.
1913	564	.....do	Do.

Cudbear—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	529	Cudbear	Free list.
1890	551	.....do	Do.
1894	461	.....do	Do.
1897	539	.....do	Do.
1909	550	.....do	Do.
1913	469	.....do	Do.

COURT AND TREASURY DECISIONS.

So-called orchil extract, a sulphonated coloring matter produced from orchil or orchil liquid, consisting of a dark green substance in the form of irregular particles with a metallic luster, was held dutiable as orchil or orchil liquid under the act of 1897 (G. A. 6048, T. D. 26383 of 1905), but orchil obtained from vegetable sources was held to come within the orchil provision (G. A. 6133, T. D. 26665 of 1905). Orchil extract, being a manufactured article, was held excluded from the provision for orchil or orchil liquid and, furthermore, held not to be a drug within the meaning of paragraph 20 of that act. The proper classification was declared to be an unenumerated manufactured article. (Siegle *v.* United States, T. D. 29431 of 1908.)

A liquid or semiliquid dyestuff known as orchil, orchil liquid, and orchil extract, obtained by maceration from lichens fermented in the presence of ammonia, which on analysis shows traces of sulphur in combination with coloring matter, sulphur being used only for the purpose of neutralizing the excess of ammonia, comes within this paragraph. (G. A. 7607, T. D. 34817 of 1914, and Abstract 37554 of 1915; see also Abstract 28371, T. D. 32488 of 1912, sustaining the importer's claim that merchandise invoiced as orchil was dutiable under paragraph 22 of the act of 1909 as vegetable extract suitable for dyeing, rather than under par. 56 as a color, and 166 Fed. 1015, of 1908, holding orchil extract to be excluded from the provision for "orchil, or orchil liquid," in par. 628 of the act of 1897, because it is a manufactured article and dutiable as an unenumerated manufactured article.)

CHLOROPHYLL EXTRACT.

GENERAL INFORMATION.

Act of 1913, paragraph 31: Extract of chlorophyll, 15 per cent ad valorem; * * * provided that no article containing alcohol shall be classified for duty under this paragraph.

Description and uses.—Chlorophyll is the green coloring matter of plants. It is used for coloring fats, oils, alcoholic liquids, soaps, ointments, and as it is nonpoisonous, for confectionery and preserves.

While the occurrence of chlorophyll is limited to plants, it is not found in all plants, being absent in fungi and certain seed plants which live as parasites and saprophytes.

The green coloring matter of plants is a mixture of at least one green substance to which the name chlorophyll is sometimes restricted and a yellow substance, carotin or xanthophyll. In certain cases there are other coloring matters present, a blue (phycocyanin), a brown (phycophaein), and a red (phycoerthrin). According to Tschirch, the color content of leaves is 0.2 to 1 grain per square meter of surface.

The chemical character of chlorophyll has not been fully settled. It occurs only in those cells exposed to the light and is essential to the formation of carbohydrates. On decomposition it yields the familiar brown color of dried leaves.

Chlorophyll is insoluble in water, but is soluble in alcohol, ether, acetone, petroleum-ether, and alkali solutions. Chlorophyll solutions have a strong red fluorescence. They are prepared by extracting finely cut leaves with alcohol or other volatile solvent. As chlorophyll is unstable, the extraction is conducted with a little ammonia or a trace of alkali carbonate is added for the preservation of the green color. It is marketed as an extract for (1) alcoholic liquids; (2) aqueous liquids; (3) a technical grade for oils, fats, and soaps; this grade is not suitable for use in alcoholic or aqueous solutions. The higher duty on alcoholic extracts has favored the importation of nonalcoholic and solid extracts.

Coal-tar dyes on account of their lower cost and greater fastness are now extensively used for the same purposes as chlorophyll.

Imports.—The imports of chlorophyll extract in the period 1910–1915 fluctuated from a minimum of 3,490 pounds, valued at $3,671, to a maximum of 10,125 pounds, valued at $8,503. The imports for 1916 and 1918 were 190 and 199 pounds, respectively.

Tariff history.—By the act of 1913 extract of chlorophyll was dutiable at 15 per cent ad valorem. By the act of 1909 chlorophyll was dutiable at 20 per cent ad valorem.

Alcoholic extracts of chlorophyll or those containing alcohol, although not specifically mentioned, would be included under paragraph 16, act of 1913, the duty depending on the content of alcohol, as follows: If containing 20 per cent of alcohol or less, 10 cents per pound and 20 per cent ad valorem; containing more than 20 per cent and not more than 50 per cent of alcohol, 20 cents per pound and 20 per cent ad valorem; containing more than 50 per cent of alcohol, 40 cents per pound and 20 per cent ad valorem.

Chlorophyll, extract of, not containing alcohol—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	20 per cent	3,899	$2,892	$578	$0.742	20.00
1911	do	6,410	2,989	598	.465	20.00
1912	do	4,460	3,586	717	.804	20.00
1913	do	7,508	8,544	1,709	1.14	20.00
1914	do	2,350	1,801	360	.766	20.00
	15 per cent	7,775	6,702	1,005	.862	15.00
1915	do	3,490	3,671	551	1.05	15.00
1916	do	190	192	29	1.01	15.00
1917	do					
1918	do	199	163	24	.819	15.00

Chlorophyll—Rates of duty.

Act of—	Par.	Tariff classification or description.[1]	Rates of duty, specific and ad valorem.
1913	31	Extract of chlorophyll	15 per cent ad valorem.
		* * * *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.	
1909	22	* * *; chlorophyll	20 per cent ad valorem.

[1] Chlorophyll not enumerated in tariff acts prior to 1909.

Court and Treasury Decisions.

Chlorophyll used for coloring foodstuffs and essential oils was held not dutiable as a color or dye under paragraph 58 of the act of 1897 but as an unenumerated manufactured article under section 6. (United States *v.* Magnus, 159 Fed., 751.)

COCHINEAL.

General Information.

Act of 1913, paragraph 455: "Cochineal." (Free list.)

Description.—Cochineal is the only important dye from animal life. It is used for pigment manufacture, for dyeing scarlets, crimsons, and as a coloring agent.

Cochineal is the female of coccus cacti, a small insect which lives on a cactus known as nepalea coccinillifera. The insect is collected on a large scale in Mexico, Guatemala, and the Canary Islands, also in Spain, Algeria, and Java. The female, possessing no wings, remains on one part of the plant and alone contains the dye. The cultivated is of greater color value than wild variety of insect.

The insects are collected just previous to the laying season by brushing into pans or baskets. They may be killed by one of three methods: 1. By dry heat; they are heated in an oven. A fine silvery dust remains on the bodies, giving the commercial varietu known as "silver gray" or "silver cochineal." 2. When hot water is used some of the coloring matter exudes, giving a brown, red, or dark color to the insects. This product is known as "black cochineal." 3. Steam is also used, the resulting product being similar to that given by hot-water killing.

The dried insects are ready for direct use after grinding, no other preparation being required for marketing. They contain from 10 to 20 per cent of a coloring matter known as carminic acid. It is a purplish red body, soluble in water and alcohol and forms crystalline salts with the alkalis. It is easily hydrolized by dilute acids to carmin red.

Ammoniacal cochineal or carminamide was formerly marketed as a solid or paste for dyeing. This product was prepared by allowing cochineal to remain in contact with ammonia.

Uses.—Cochineal was at one time extensively used for the dyeing of crimsons and scarlets on wool and silk, with aluminum and tin salts,

and to some extent for purples on wool. The coal-tar dyes, azo scarlets, and acid reds have largely displaced cochineal. At present it has limited use in dyeing scarlet on animal fibers and is the basis of the "carmin lake" pigment with alum. As cochineal is not poisonous it is used in the coloring of foodstuffs, candies, and in face powder.

Imports.—In the period 1909–1915 the imports varied from 102,694 pounds, valued at $33,875 in 1909, to 177,799 pounds, valued at $55,682 in 1912. The maximum import was, in 1916, 772,416 pounds valued at $358,914. In 1918, 160,547 pounds were imported valued at $75,924.

Prices.—"Cochineal, gray, black," is quoted in the first half of 1912 at 27 to 29 cents per pound; in the last half of the same year the price was 48 to 50 cents per pound. The price in 1917 was 75 to 80 cents per pound, and in 1918, 54 to 55 cents per pound. This figure abruptly rose to 80 to 85 cents per pound in 1919, gradually receding to 62 to 67 cents per pound in the last half of 1919.

"Cochineal, rosy, black," is quoted in the first half of 1912 at 25½ to 27 cents per pound, increasing in the latter part of the year to 43 to 45 cents per pound. In 1916, this figure reached 85 to 90 cents per pound, receding to 55 to 59 cents per pound in January, 1918. This price abruptly rose to 95 cents to $1 per pound in January, 1919, decreasing to 65 to 70 cents per pound in the latter part of 1919.

"Cochineal, Teneriffe silver": The prices on this variety varied only slightly from those of the "Cochineal, rosy, black," given above.

Tariff history.—Cochineal has been specifically shown on the free list as far back as 1890.

Cochineal—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				
1909	Free	102,694	$33,875		$0.330	
1910	do	150,811	41,445		.275	
1911	do	102,670	25,269		.246	
1912	do	177,799	55,682		.313	
1913	do	109,089	44,249		.406	
1914	do	138,139	53,260		.386	
1915	do	115,430	38,454		.333	
1916	do	772,416	358,914		.465	
1917	do	124,745	46,802		.375	
1918	do	160,547	75,924		.473	
Calendar year—						
1918	do	237,402	116,660		.491	
1919	do	116,014	52,029		.448	
1920 [1]	do	106,804	44,215		.404	

[1] 6-month period ending June 30, 1920.

Cochineal, gray, black—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	27–29	48–50	48–50	60–75	60–75	75–80	54–55	80–85	62–67
April	27–29	48–50	48–50	60–75	.....	75–80	54–55	67–75	60–67
July	48–50	48–50	48–50	60–75	.....	75–80	56	62–67	60–62
October	48–50	48–50	60–75	60–75	75–80	75–80	(1)	62–67	60–62

[1] Nominal.

Cochineal, rosy, black—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	25½–27	43–45	45	65	65	85–90	55–59	95–100	65–70
April	25½–27	43–45	45	65	82–85	85–90	55–56	65– 70	65–70
July	43 –45	43–45	45	65	85–90	85–90	70	65– 70	63–65
October	43 –45	45	65	65	85–90	85–90	(1)	65– 70	63–65

[1] Nominal.

Cochineal, Teneriffe, silver—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	27½–29	.....	.....	.....	55	95–98	54–55	90–95	67–70
April	27½–29	.....	.....	.....	80–82	95–98	54–55	70–75	67–70
July	.....	.....	.....	.....	95–98	95–98	63–69	67–70	65–70
October	.....	.....	.....	.....	95–98	95–98	(1)	67–70	65–70

[1] Nominal.

Cochineal—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1890	541	Cochineal	Free.
1894	446	.....do	Do.
1897	527	.....do	Do.
1909	539	.....do	Do.
1913	455	.....do	Do.

CUTCH.

General Information.

Not mentioned, included under—

Act of 1913, paragraph 624: Tanning material: Extracts of * * * and woods used expressly for dyeing and tanning, * * * free.

Description.—Under the term "cutch" consideration is given to the extract prepared from the wood of the *Acacia catechu* and from the wood of allied varieties—*Acacia catechuoides, Acacia sundra.* Cutch is known also as acacia catechu, catechu, pegu catechu, Brown cutch, Brown catechu. The term "terra japonica," now practically obsolete and sometimes applied to cutch, more correctly means gambier.

The areca catechu or betel-nut palm is mentioned by several authors as a source of areca catechu used in dyeing.[1] The German Pharmacopœia of 1870–1880, stated that the catechu was derived from

[1] Commercial Products of India: Sir George Watt, 1908; Dictionary of The Economic Products of India; Areca catechu, L. Western Druggist—John Uri Lloyd, May, 1897. (Reprint Library of Congress.)

the areca catechu. In the 1890 edition this was corrected as an error. The betel nut is a masticatory of great antiquity. At present the nut is chewed with the betel pepper by about 200,000,000 people in India and surrounding territory. It is an astringent and is said to stimulate the digestive organs and prevent dysentery. The betel-nut palm is extensively cultivated in India, the nut being an important agricultural product. An astringent extract known as "kossa" is prepared by boiling the nuts with water in copper kettles. It is used to flavor and color inferior betel nuts. Little data is available on the extent of manufacturing of "kossa" or of the existence of a separate trade in the extract kossa itself. Apparently, it is rarely if ever exported from India. Small quantities of betel nuts are imported into the United States for the extraction of arecoline, an alkaloid used in veterinary practice.

The acacia catechu is a crooked shrubby tree of abundant distribution and occurrence in the dry parts of India, East Indies, and the various Provinces of Hindustan. It is common in East Africa, where it is valued for its wood. No extract appears to have been made in Africa. The tree is cultivated in India and Burma. The tree varies from 6 to 18 inches in diameter and 15 to 45 feet in height. Trees 1 foot or more in diameter are cut for extract making. The older trees are considered more desirable for this purpose. Wood containing the greatest number of white spots yield the most catechin.

The cutch manufacture is carried out from June 1 to March 31, December to March being the period of most intensive operations. The tree is cut when the wood contains the most sap. After removing the bark and sapwood the dark red heartwood is cut into chips or small strips. Usually three men work together—one cutting and hauling, one chipping, and the third preparing the extract.

"The chips are packed into earthen pots holding 3 to 4 gallons of water and the whole is boiled down to one-half; the chips are then taken out and the liquid of 20 to 25 pots is gradually poured into a large iron pan or caldron and again boiled and stirred and fresh liquid added from the earthen pots until the fluid attains the consistency of sirup. The caldron is then taken off the fire and the contents stirred continuously with a wooden paddle for 4 hours or more till the mass cools and can be handled. It is then taken out and spread on leaves arranged within a wooden frame like a brick mold. It is left overnight and in the morning the extract is dry and ready to be cut up into pieces for the market."

Each caldron yields 36 to 44 pounds a day, or 2,000 to over 6,000 pounds per season, depending on the quality and location of the wood and the weather. A ton of cutch wood yields about 250 to 300 pounds of cutch. The heartwood yields from 3 to 11 per cent cutch. Cutch occurs in blocks or cakes or irregular masses of dark brown color, brittle, somewhat porous structure, glossy when freshly broken and frequently containing bits of leaves, etc.

A purer product known as "koth" and called pale catechu is prepared in India by crystaling catechu on twigs immersed in the wood extract. The twigs are removed and the crystalline substance adhering is pressed into irregular cubes. This is consumed in India largely for chewing and is frequently confused by Europeans with cutch

Another product of the acacia catechu tree is known as kursal or khersal. This pale crystalline substance is gathered from cavities in the wood by choppers and is regarded as a valuable medicine by the Hindus.

Cutch contains about 50 per cent tannin—as catechu tannin 35 per cent and catechin 13 to 34 per cent, together with quercitron, gum, and extractive matter.

Catechin forms colorless needles readily soluble in boiling water and cold alcohol. Although it is frequently referred to as catechuic acid, it is neutral to litmus and possesses no acid properties. Catechin dissolved in alkaline solutions turns brown on exposure to air. An aqueous solution precipitates lead or mercury salts or albumen, but it does not precipitate gelatin, alkaloids or tartar emetic. Catechu tannic acid forms a red brown powder soluble in water and in alcohol. An aqueous solution is precipitated by gelatin, albumen, or sulphuric acid. Its alkaline carbonate solution readily oxidizes on exposure to air to a reddish color; on acidification of this solution a dark red precipitate is formed, rubinic acid. Its solution in caustic alkalis oxidizes on exposure to air to a dark brown color; on acidification a blackish precipitate is formed, japonic acid. This substance is also formed by oxidation with an alkali dichromate. The dyeing properties of cutch depend on these oxidation products.

Uses.—Cutch is used principally in dyeing and textile printing. It is used to some extent in tanning and as a constituent of boiler compounds and in medicine as an astringent.

Cutch is used in the production of the well-known "cutch brown," with copper and chrome salts for mordants. It is of excellent fastness to light, acids, alkalies, and bleaching solutions. Cutch is used in dyeing compound shades with logwood or fustic, also as a mordant for fixing basic dyes and as a weighting agent for silks. The coal-tar "sulphur dyes" have offered severe competition to cutch and have displaced it to a considerable extent.

Domestic production.—Cutch is not produced in this country. It is a product of foreign origin. The solid cutch is made in India and surrounding territory. A part of the imported solid cutch is dissolved in water and sold as a liquid extract. The preparation of this liquid extract constitutes the domestic industry involved in the preparing of cutch for the market.

Imports.—Imports of cutch are not separately given in Foreign Commerce and Navigation. In 1914, 328,940 pounds were imported, valued at $16,187. (Chemicals and allied products used in the United States Department of Commerce. Miscellaneous No. 81.) The chief source of the 1914 import was the Straits Settlements, British India, and England.

Tariff history.—In the acts of 1894 and 1897 cutch is specifically mentioned on the free list. The acts of 1909 and 1913 did not specifically mention cutch. It was, however, classified free of duty under paragraph 624, act of 1913.

Tariff considerations.—The chief use of true cutch (acacia catechu) is for dyeing, while the chief use of mangrove extract is for tanning. In a tariff classification based on the chief use of a vegetable extract, either as a tanning or a dyeing material, the wording "cutch not including mangrove extract" would separate these two products.

Cutch—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value pe unit of quantity	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				*Per cent.*
1908	Free	2,078,468	$66,895		$0.032	
1909	do	1,368,114	55,060		.040	
1910	do	28,477	1,278		.045	

Cutch, slabs—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918	1919	1920	Month.	1918	1919	1920
	Cents.						
January	20	Nominal.	Nominal.	July	None.	Nominal.	Nominal.
April	20	Nominal.	Nominal.	October	Nominal.	Nominal.	Nominal.

Cutch, rangoon—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1919	1920	Month.	1919	1920
		Cents.		*Cents.*	
January		18–20	July	18–20	Nominal.
April		18–20	October	18–20	Nominal.

Cutch, solid, 68 per cent basis, f. o. b. Seattle—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

	1918	1919	1920 [1]	1920 [2]		1918	1919	1920 [1]	1920 [2]
		Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*	*Cents.*
January		11½–12	10–12	14–16	July		11½–12	10–12	Nominal.
April		11½–12	10–12	14–16	October	[3] 11½–11½		10–12	Nominal.

[1] Borneo bales. [2] South American bags. [3] Not listed previously.

Cutch, liquid—Prices, wholesale, per pound, New York.[1]

[From Oil, Paint, and Drug Reporter.]

	1916	1917	1918	1919	1920		1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	8–9	11–12	19–21	12–14	.....	July	(2)	.....	14	12–14	.....
April	(2)	.....	12–15	12–14	.....	October	(2)	.....	12–14	.....	.....

[1] Not quoted prior to 1916. [2] Not given in 1917 annual.

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Cutch—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1883....	531	Cutch	Free.
1890....	554	.....do	Do.
1894....	454	.....do	Do.
1897....	542	.....do	Do.
1909....	20	Drugs, * * * and woods used expressly for dyeing or tanning: * * * advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the drugs and the prevention of decay or deterioration pending manufacture.	One-fourth of 1 cent per pound.
		And in addition thereto	10 per centum ad valorem.
		Provided, That no article containing alcohol, or in the preparation of which alcohol is used, shall be classified for duty under this paragraph.	
	22	Extracts and decoctions of logwood and other dyewoods, and extracts of bark, such as are commonly used for dyeing or tanning, not specially provided for in this section.	Seven-eighths of 1 cent per pound.
		Extracts of * * * woods other than dyewoods, not specially provided for in this section.	Five-eighths of 1 cent per pound.
		All extracts of vegetable origin suitable for dyeing, coloring, staining, or tanning, not containing alcohol and not medicinal, and not specially provided for in this section.	15 per centum ad valorem.
	499	Articles in a crude state used in dyeing or tanning, not specially provided for in this section.	Free.
1913....	624	Tanning material; extracts of * * * barks and woods other than dyewoods, such as are commonly used for tanning, not specially provided for in this section; * * * and woods used expressly for dyeing or tanning, whether or not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process; and articles in a crude state used in dyeing or tanning; all the foregoing not containing alcohol and not specially provided for in this section.	Do.

Court and Treasury Decisions.

Cutch made from the bark of the mangrove tree is free of duty under the provision of paragraph 624 of the act of 1913 for "extracts of oak and chestnut and other barks and woods other than dyewoods such as are commonly used for tanning." Cutch made from the wood and leaves of the acacia catechu tree is dutiable at the rate of three-eighths of 1 cent per pound under paragraph 30 as an extract of vegetable origin suitable for dyeing. (G. A. 8265; T. D. 38055, of 1919.) Mangrove extract classified under paragraph 30 as an extract of vegetable origin suitable for dyeing was held exempt from duty as tanning material under paragraph 624. (Ab. 38085, of 1915.) In 1916 the Treasury Department held acacia catechu cutch (or the "A. C. L." cutch) and the mangrove bark cutches, known as "B. S. L." cutch and "block" cutch, used chiefly for dyeing, to be dutiable at the rate of three-eighths of 1 cent per pound under paragraph 30, and other forms of mangrove bark cutch, which are used chiefly for tanning, exempt from duty under paragraph 624. (T. D. 36180, of 1916.) An extract of the bark of the mangrove tree used chiefly in tanning and commercially known as "cutch" was held exempt from duty under paragraph 542 of the act of 1897. "Cutch" was declared to be a word derived from the specific name of the acacia catechu. The cutch early imported into the United States, the court said, was probably prepared altogether from the wood of this tree, and was used chiefly, though not altogether, for dyeing. Before 1897 an extract from the bark of the mangrove was imported for the same use and was commercially known as cutch. (United States *v.* Marden, 175 Fed., 153, of 1909; T. D. 30344, of 1910.)

FUSTIC.

SUMMARY.

Fustic is an important yellow dyewood imported from the West Indies, Mexico, Central and South America. It does not grow in the United States. For many purposes the domestic osage orange and quercitron are used as substitutes for fustic; they are of lower cost and have displaced fustic to a considerable extent.

The extracts and preparations of fustic are made by methods and equipment similar to those used in the manufacture of logwood extract. They are made at plants manufacturing other wood extracts.

The chief use of fustic preparations is for dyeing uniform and tent cloths.

Crude fustic wood is free. The extracts are dutiable. In 1894 the rate on extracts was 10 per cent ad valorem. In 1897 this was changed to seven-eighths of 1 cent per pound. By the act of 1913 this rate was reduced to three-eighths of 1 cent per pound.

GENERAL INFORMATION.

Act of 1913, paragraph 624: "Tanning material * * * and articles in a crude state used in dyeing or tanning; all the foregoing not containing alcohol and n. s. p. f. in this section, free."

Act of 1913, paragraph 31: * * * all extracts of vegetable origin suitable for dyeing, coloring, or staining, n. s. p. f. in this section, all the foregoing not containing alcohol and not medicinal, three-eighths of 1 cent per pound.

Description.—Fustic is an important natural yellow dyestuff. It is used as a self-color for yellow to olive shades and more extensively in dyeing compound shades with other natural dyes.

Commercially it is known as Cuba wood, yellow wood, and old fustic. It is the heart wood of a tree botanically known as the *Morus* or *Maclura tinctoria*. The domestic osage orange and the common mulberry are closely related. An entirely different product known as "young fustic" derived from the sumac "*Rhos cotinus*," found in Southern Europe and West Indies, was used in Europe previous to the introduction of the American fustic. The dyeing properties and chemical characteristics of "young fustic" are distinctly different from those of the American fustic. As the shades were of poor fastness "young fustic" is no longer in use.

The fustic tree grows in the West Indies, Mexico, Central and South America. The best quality is cut in Cuba and Tampico, the poorer grades coming from Jamaica and Brazil; the latter species are somewhat different from the Cuba variety both botanically and tinctorially.

The tree grows to the height of 60–70 feet, with a diameter of about 30 inches. While it has a wide range of growth it is not found on the highlands. The lowlands of Mexico and of the tropical American coasts are especially favorable for its best development. The fustic tree is of common occurrence in Colombia, Venezuela, Honduras, Costa Rica, and Panama.

The stand is very thin; usually there are only one or two trees per acre. The trees are cut in 4 to 6 foot lengths and the sap wood removed, as only the heart wood is of tinctorial value. The wood is very heavy, making its transportation through the forest difficult. Fustic wood is a pale-yellow hardwood. On account of its compactness and indestructibility it is valued as a cabinet wood.

There are two coloring matters in fustic—morin or moric acid and maclurin or moritannic acid. Morin, the principal coloring matter, forms colorless needles, slightly soluble in hot water and readily soluble in alkaline solutions; chemically it is a flavone derivative and forms insoluble compounds with metallic salts, varying in shade from yellow to olive green.

Maclurin or moritannic acid is more soluble in water, and, like morin, forms insoluble compounds with metallic salts. The "patent fustin" is a diazobenzene sulphate derivative of maclurin.

Fustic gives a bright yellow with tin and aluminum mordants, of poor fastness to light and fair fastness to washing. With chromium mordants olive shades and old-gold shades are formed; with copper and iron salts greenish olive shades are given. Unlike the yellows, the olive shades are of moderate fastness to light and washing.

Fustic extracts are marketed as liquids of 42° Tw. and 51° Tw. and as a "solid extract" and "fustic extract crystals."

Uses.—Previous to the introduction of coal-tar colors, fustic was used in large quantities as a self color for yellows on wool. The synthetic dyes, on account of their greater economy of application and fastness, have largely displaced fustic for this purpose. Its present uses are in the dyeing of compound shades, drabs, olives, and browns, and in shading logwood and other blacks for producing a dead black.

On cotton it has had extensive use in the dyeing of khakis, tent and uniform cloths. On silk its chief use is for compound shades and for the shading of blacks.

Domestic quercitron and osage orange extracts have displaced fustic to some extent. As a substitute, osage orange is used on both leather and textiles, while quercitron is used on textiles. For certain uses these products have not displaced fustic.

Domestic production.—According to old practice the wood was used directly by the dyer in a chipped or rasped form. To-day the extracts are used almost exclusively. The method of their preparation and the equipment is similar to that used for logwood extracts. The chips are extracted with hot water under pressure and the resulting liquid evaporated under reduced pressure to a liquid extract of 51° Tw. or to a solid extract.

The producers of fustic extract without exception manufacture other dyewood or tanning extracts. As fustic extract is a small per cent of their production it is difficult to estimate the actual capital invested in plants for its production. The fustic extract plants are located in or near the North Atlantic seaports.

In 1914 five establishments produced 4,509,943 pounds of fustic extract, valued at $222,804. This represents 15.5 per cent of the weight and 15 per cent of the value of logwood extract produced in the same year. Production for other years is not available. The exports and imports of fustic extract are not separately given. The imports of fustic wood from 1909 to 1914 varied from 2,466 tons,

valued at $34,752, in 1909, to 5,816 tons, valued at $82,887, in 1914. The maximum import of fustic wood was in 1916, when 17,469 tons were imported, valued at $289,913. In 1917 this import dropped to 5,195 tons, increasing in 1918 to 16,259 tons.

Foreign manufactured extract is not reported as competitive to domestic made extract. The United States is conveniently located in respect to the supply of fustic wood. The present requirements of the United States could be met by one good-sized factory. There is at present no fustic extract made at the source of the wood supply, West Indies or Central America, as in the case of logwood.

The reason for the great rise in prices of this commodity, was the extreme shortage due to difficulty in importation. The demand was very great because the supply of chemical and coal-tar dyes had been shut off by the British blockade of Germany. Early in 1918, the call came for the shipping of supplies and men abroad. The Government even took over the bottoms in use for various kinds of import and export trading, so the traders of natural dyestuffs were among the first to suffer. The demand for dyes became so great that extract makers utilized Osage Orange grown in the southern portion of the United States which had never been used before, and even then the demand far exceeded the supply. There was such a shortage of dyewood extracts that by allocation of certain vessels to take on cargoes of dyewoods the Government relieved the situation only slightly.

After the signing of the armistice the restrictions in shipping were removed almost at once, but even then it was hard to secure space. In 1919 the prices began to recede and continued to do so through 1920.

Prices.—Stick fustic wood was quoted at $12–$23 a ton in the period 1912–1914, from this figure it increased to the maximum, $55–$80 a ton in January, 1918, receding to $35–$40 in 1920. Chipped fustic wood sold for 1½–2 cents per pound in 1912 to 1915, increasing to 7–8 cents per pound in 1918. During 1919 it sold for 4–6 cents per pound.

Fustic extract 51° Tw. sold for 6–8 cents per pound in the period 1912 to July, 1915; this price abruptly rose to 40 cents per pound in January, 1916, receding to 14–15 cents in the latter part of 1917. In 1920 the extract was 12½–14 cents per pound. Solid fustic extract is quoted at 8–11 cents per pound during the period 1912 to July, 1915; from this figure it abruptly increased to 55 cents per pound in 1916. After a decrease from 40 cents to 24 cent in 1917 the price receded to 17½–19 cents per pound in January, 1920. Fustic crystals are quoted, January, 1915, at 10–12 cents per pound; in January, 1916, at 58–60 cents per pound, and in January, 1917, at 20–22 cents per pound. During 1918 the price increased to 30–33 cents per pound, receding to 22–24 cents per pound in 1920.

Tariff history.—Crude fustic is on the free list. By the act of 1913 dyewood extracts are dutiable at three-eighths of 1 cent per pound. By the act of 1909 and 1897 fustic extract was dutiable at seven-eighths of 1 cent per pound. By the act of 1894 fustic extract was dutiable at the rate of 10 per cent ad valorem.

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Fustic wood—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Tons.				
1909	Free	2,466	$34,752		$14.09	
1910	do	5,816	82,887		14.25	
1911	do	5,379	72,673		13.70	
1912	do	3,104	45,833		14.76	
1913	do	3,785	53,303		14.08	
1914	do	7,121	100,501		14.11	
1915	do	12,354	179,959		14.56	
1916	do	17,469	289,913		16.59	
1917	do	5,195	142,431		27.41	
1918	do	16,259	435,428		26.77	
1919	do	4,486	85,096		18.97	

Fustic, stick—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	$12–23	$12–23	$12–23	$18–30	$22–30	$30–35	$45–50	$55–80	$35–40
April	12–23	12–23	12–23	18–30	25–30	30–35	45–60	42–48	35–40
July	12–23	12–23	12–23	18–30	30–35	30–35	40–55	42–48	35–40
October	12–23	12–23	18–30	22–30	30–35	55–60	50–70	30–35	40–50

Fustic, young root—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	$45	$45	$45	$45	$45	$45	$45	[1]	.....
April	45	45	45	45	45	45	40	[1]	.....
July	45	45	45	45	45	45	35–40	[1]	.....
October	45	45	45	45	45	45	[2]	[1]	.....

[1] No offers. [2] None.

Fustic chips—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	1½–2	1½–2	1½–2	1½–2	5–7	6–7	7–8	4–6	4–6
April	1½–2	1½–2	1½–2	1½–2	5–7	6–7	7–8	4–6	4–6
July	1½–2	1½–2	1½–2	2 –2½	6–7	6–7	3½–5½	4–6	4–6
October	1½–2	1½–2	1½–2	5–7	6–7	6–7	4–6	4–6	4–6

Fustic extract liquid, 42°—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1919	1920	Month.	1919	1920
	Cents.	*Cents.*		*Cents.*	*Cents.*
January	[1] 13–15	10½–12	July	13–15	11½–12½
April	13–15	11½–12½	October	13–15	11½–12½

[1] Not listed previously.

Fustic extract, liquid, 51°—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	6–8	6–8	6–8	6 – 8	40	15–20	16–17	15–16	12½–14
April	6–8	6–8	6–8	6 – 8	35	15–20	15–17	15–16	14 –15
July	6–8	6–8	6–8	6 – 8	26–30	14–15	14–15	15–16	14 –15
October	6–8	6–8	6–8	9½–11	22–26	14–15	15–16	15–16	14 –15

Fustic extract, solid—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January	8–11	8–11	8–11	8–11	55	40	25–26	26–31	17½–19
April	8–11	8–11	8–11	8–11	55	40	25–26	23–25	20 –22
July	8–11	8–11	8–11	8–11	53–40	24–25	27–28	23–25	22 –24
October	8–11	8–11	8–11	15	35–40	24–25	26–31	23–25	22 –24

Fustic extract, crystals—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1914	1915	1916	1917	1918	1919	1920
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
January		10–12	58–60	20–22	27	30–33	22–24
April		[1]	[1]		27	28–30	22–24
July		[1]	[1]		30	28–30	25–27
October	[2]	[1]	[1]		30–33	28–30	25–27

[1] Not given in oil, paint, and drug weeklies. [2] Nominal.

Fustic (crude woods)—Free.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1890	492	Articles in a crude state used in dyeing or tanning, n. s. p. f. in this act.	Free.
1894	386	.....do.....	Do.
1897	482	.....do.....	Do.
1909	499	.....do.....	Do.
1913	624	Tanning material * * * and articles in a crude state used in dyeing or tanning; all the foregoing not containing alcohol and n. s. p. f. in this section.	Do.

Fustic (extracts)—Dutiable.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1894	18	Extracts and decoctions of logwood and other dyewoods, * * * such as are commonly used for dyeing or tanning.	10 per centum ad valorem.
1897	22	Extracts and decoctions of logwood and other dyewoods, * * * such as are commonly used for dyeing or tanning, n. s. p. f. in this act.	Seven-eighths of 1 cent per pound.
1909	22	Extracts and decoctions of logwood and other dyewoods, * * * such as are commonly used for dyeing or tanning, n. s. p. f. in this section.	Do.
1913	30	Extracts and decoctions of nutgalls, Persian berries, sumac, logwood, and other dyewoods, and all extracts of vegetable origin suitable for dyeing, coloring, or staining, not specially provided for in this section; all the foregoing not containing alcohol and not medicinal.	Three-eighths of 1 cent per pound.

NATURAL INDIGO.

Act of 1916—Group III. Natural alizarin and indigo, and colors, dyes, or color lakes obtained, derived, or manufactured therefrom, 30 per cent ad valorem.

General Information.

Description.—Indigo is the most important and valuable dye. Only a small part of the world's supply is furnished by the natural product. The synthetic indigo made from coal-tar derivatives, by reason of its cost, purity, and uniformity, has largely displaced the natural product. Natural indigo was used in Egypt and India from ancient times. Sanskrit records describe its preparation, and mummy wrappings dyed with indigo have been found in Egypt.

The different species of the Indigofera are the most important indigo-yielding plants. India is the largest producer, the Bengal, Madras, Oude, and Kurpahs Provinces export products bearing their names. Indigo is also extensively cultivated in China, Japan, Philippines, Africa, Brazil, and Guatemala. The *Isatis tinctoria* or woad plant was at one time extensively cultivated in Europe. It still has some application, but is never used alone. Nearly a dozen plants not species of the Indigofera are cultivated in the different indigo-producing countries.

Uses.—At present natural indigo is used in dyeing wool by the fermentation vat. The synthetic indigo is preferred for all other uses, printing, dyeing cotton goods, etc., on account of its uniformity, purity, lower cost, and ease of application. Natural indigo is also used to a small extent in the preparation of "indigo extracts." These are soluble acid blues used on wool and silk. They possess greater brightness, but are of inferior fastness in comparison with indigo proper. The synthetic indigo is preferred for their preparation.

Production.—The production as carried out in India is as follows: The seeds are sown in early spring. In June the plant is cut, having attained a height of 3 to 5 feet; fresh leaf soon develops, and in two or three months a second crop is ready. The leaves contain about 1.2 per cent coloring matter, not as indigo, but as a glucoside called indican. In the preparation of indigo, bundles of cut plants are placed upright in vats and covered with water. Active fermentation soon begins, and in about 10 hours the indican has been changed by an enzyme to indigo, which in turn has been reduced and remains dissolved, imparting a yellow to green color to the solution. This solution is drawn off and run into the "beaters," where the indigo is precipitated by blowing through air, spraying or agitating by a beating wheel. After settling the indigo sludge is pumped into a kettle, where it is heated to prevent further fermentation and dissolve out impurities. The sludge is drained on cloth and pressed in canvas-lined boxes. The resulting cake is cut into small cubes and dried. The impurities and the quality of natural indigo differ widely; they depend on the care and method of preparation as well as the source.

British India in 1907-8 had 405,905 acres under cultivation. The exports for that year amounted to 3,249,000 pounds, valued at

$2,665,766. In 1909–10 the acreage decreased to 294,970, gradually decreasing to 145,792 acres in 1914–15. The greater demand for natural indigo caused by the war shortage increased the acreage in 1916–17 to 764,918.

For years the synthesis of indigo had been a subject much studied by chemists. In 1870 Baeyer synthesized indigo from isatin. Later other methods were discovered but could not commercially compete with natural indigo until the Heuman method, when naphthalene was used as a raw material. The Badische Anilin and Soda Fabrik commercialized this method and placed "Indigo Pure" on the market in 1897. Other German firms later manufactured indigo, resulting in a complete commercial victory for the synthetic over the natural indigo.

The shortage of German synthetic indigo during the war stimulated the growth of natural indigo. To-day the United States manufactures sufficient synthetic indigo to supply our entire American demands.

Imports.—The domestic imports of natural indigo had a direct relation to the development of the German synthetic product in 1897. As the German synthetic indigo captured the world's market, the production of natural indigo and hence the use of the latter correspondingly decreased.

In 1909 the United States imported 7,989,014 pounds of synthetic indigo, valued at $1,242,077, from Germany. During the same year our import of natural indigo from British India was 131,158 pounds, valued at $72,247; in addition 129,545 pounds of indigo, valued at $85,890, were imported from England; this last amount is presumed to be the natural indigo.

In 1916 no synthetic indigo was imported from Germany. The exclusion of the German indigo from the world's market greatly increased the production of natural indigo in India and the other indigo-producing countries. The United States imported from India, in 1916, 648,280 pounds of natural indigo, valued at $1,463,081. This import from India increased to 555,334 pounds, valued at $1,106,036, in 1917; and in 1918 it was 1,259,224 pounds, valued at $1,882,662. The total imported natural indigo in 1918 was 2,113,912 pounds, valued at $3,276,557; in 1917 this import was 1,238,693 pounds, valued at $2,459,835. The total imports of natural and synthetic indigo in the period 1909 to 1913 varied from a minimum of 6,908,751 pounds in 1911, valued at $1,152,518, to 8,249,975 pounds in 1909, valued at $1,400,286. During the war the maximum total imports were made in the year 1915, amounting to 7,983,112 pounds, valued at $1,604,767. In 1917 this import figure dropped to 545,105 pounds, valued at $960,038.

The imports of natural indigo in 1919 rapidly decreased. In 1919 the United States manufactured synthetic indigo in excess of the domestic needs.

Prices.—The prewar price of natural indigo varied according to the source and quality of the article. In the price tables complete quotations are given for each grade, these figures ranging from 50 cents to $3 per pound until 1916, when the prices increased through that year and 1917 to $1.10 and $5 per pound. This was due to the scarcity of synthetic indigo. The prices for the natural indigo have gradually receded since the manufacture of synthetic indigo in America.

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The prewar price of synthetic indigo remained at 18 to 20 cents per pound until the outbreak of the war in 1914, when the price jumped to 65 cents per pound. It remained at that figure until 1916, when it rose rapidly to $2 per pound, due to the fact that no synthetic indigo was imported from Germany. With the supply of indigo cut off, the United States rose to the occasion, and by 1919 was producing synthetic indigo in excess of domestic needs; hence a steady decline in price to 75 cents per pound, which is about five times the prewar price.

Tariff history.—Natural indigo has been specifically shown on the free list up to the act of September 8, 1916, when natural alizarin and indigo, and colors, dyes, or color lakes obtained, derived, or manufactured therefrom, were dutiable at the rate of 30 per cent ad valorem.

Exports of indigo from British India, 1907–1918.

[Source: Statistical Abstract Relating to British India, 1907–1916. Sea-Borne Trade of British India, 1916–1918.]

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Pounds.			*Pounds.*	
1907–8	3,638,880	$2,067,528	1913–14	1,225,168	$690,741
1908–9	2,793,952	1,591,277	1914–15	1,919,904	2,918,396
1909–10	2,022,832	1,141,408	1915–16	4,696,384	6,743,971
1910–11	1,897,168	1,087,804	1916–17	3,833,760	6,853,846
1911–12	2,145,360	1,219,229	1917–18	3,478,944	4,957,825
1912–13	1,327,984	714,183	1918–19	3,663,184	4,050,583

Indigo, natural and artificial—Imports by countries (fiscal years).

Imported from—	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Valve.
	Pounds.		*Pounds.*		*Pounds.*	
Belgium			134,014	$20,518		
British India	131,158	$72,247	125,061	66,199	189,538	$88,782
England	129,545	85,890	291,126	84,368	89,627	54,027
France						
Germany	7,989,014	1,242,077	6,985,160	1,023,543	6,488,267	987,082
All other	255	72	3,328	1,314	141,319	22,627
Total	8,249,972	1,400,286	7,538,689	1,195,942	6,908,751	1,152,518

Imported from—	1912		1913	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Belgium	108,182	$14,723		
British India	192,479	100,832	179,075	$58,882
England	63,315	34,794	52,759	29,834
France			19,841	2,819
Germany	7,032,023	965,047	7,212,451	974,502
All other	262,068	37,746	248,382	36,860
Total	7,658,067	1,153,142	7,712,508	1,102,897

Indigo, natural or synthetic—Imports by countries (fiscal years).

Imported from—	1914		1915		1916		1917[1]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
British India	62,776	$34,224	74,399	$113,519	648,280	$1,463,081	88,321	$251,585
China					3,411,980	2,954,894		
England	78,122	43,801	231,320	343,987	1,313,373	2,950,125	246,647	568,934
Germany	7,448,412	938,097	6,880,921	896,069				
Switzerland	535,801	77,079	630,288	121,537	385,202	153,702	134,262	78,101
All other	100	25	158,781	121,866	840,748	713,868	68,182	61,420
Total	8,125,211	1,093,226	7,975,709	1,596,978	6,599,583	8,235,670	537,412	960,038

[1] July 1 to Sept. 8, 1916.

Indigo, natural—Imports by countries (fiscal years).

Imported from—	1917[1]		1918	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
British India	554,334	$1,106,036	1,259,224	$1,882,662
China			95	19
England	517,800	1,087,269	441,290	687,474
Germany				
Switzerland	9,220	42,523	174,969	400,762
All other	157,339	224,007	238,334	305,640
Total	1,238,693	2,459,835	2,113,912	3,276,557

[1] Sept. 9, 1916, to June 30, 1917.

Indigo, natural and artificial (acts of 1897 and 1909)—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	8,249,975	$1,400,286		$0.170	
1910	do	7,636,690	1,195,942		.157	
1911	do	6,908,751	1,152,518		.167	
1912	do	7,697,482	1,160,473		.151	
1913	do	7,712,488	1,102,893		.143	
1914	do	2,649,253	342,255		.129	

Indigo, natural or synthetic, dry or suspended in water (act of 1913)—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	Free	5,603,265	$772,873		$0.138	
1915	do	7,983,112	1,601,767		.201	
1916	do	6,794,518	8,451,504		1.244	
1917	do	545,105	960,038		1.761	

Indigo, synthetic (act of 1916)—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1917	30 per cent	885,581	$558,990	$167,697	$0.631	30
1918	do	942,946	553,226	165,967	.587	30
1919	do	358,867	197,176	59,153	.549	30
FROM PHILIPPINE ISLANDS.						
1917	Free	1,116	$166		$0.149	
1918	do					
1919	do					

Indigo, natural (act of 1916)—Imports for consumptjon—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1917	30 per cent	1,228,714	$2,447,292	$734,187	$1.991	30
1918	do	2,141,382	3,261,948	978,584	1.523	30
1919	do	791,251	961,610	288,483	1.211	30
FROM PHILIPPINE ISLANDS.						
1917	Free	3,272	$2,069		$0.632	
1918	do					
1919	do					

Indigo, Bengal, low grade—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.67½	$0.67½	$0.67½	$2.00	$3.00–$3.50
April	.67½	.67½	67½	3.00	3.50– 5.00
July	.67½	.67½	.67½	$3.00– 3.50	3.50– 5.00
October	.67½	.67½		3.00– 3.50	3.50– 5.00

Month.	1917	1918	1919	1920
January	$3.50–$5.00	$2.50–$2.75	$3.25–$3.50	$2.25–$2.50
April	3.75– 4.00	2.50– 2.75	3.00– 3.50	2.25– 2.50
July	3.75– 4.00	2.25– 2.75	2.25– 2.50	2.00– 2.25
October	3.75– 4.00	3.00– 3.75	2.25– 2.50	2.00– 2.25

Indigo, Kurpahs—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.50–$0.60	$0.50–$0.60	$0.50–$0.60	Nominal.	Nominal.
April	.50– .60	.50– .60	.50– .60		
July	.50– .60	.50– .60	.50– .60		
October	.50– .60	.50– .60			

Month.	1917	1918	1919	1920
January	Nominal.	$2.75–$2.90	$2.25–$2.75	$2.00–$2.25
April		2.75– 2.90	2.25– 2.75	2.00– 2.25
July		2.25– 2.50	2.00– 2.25	1.85– 2.00
October	$3.50	2.25– 2.75	2.00– 2.25	1.60– 1.90

Indigo, Madras—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.58–$0.65	$0.58–$0.65	$0.58–$0.65	$1.22	$1.50
April	.58– .65	.58– .65	.58– .65	1.22	1.50
July	.58– .65	.58– .65	.58– .65	$0.93– .95	2.50
October	.58– .65	.58– .65	1.22	.92– .93	2.50

Month.	1917	1918	1919	1920
January	$1.03	$1.10–$1.80	$0.80–$1.10	$0.95–$1.00
April	$1.40– 1.45	1.10– 1.30	.80– 1.00	.95– 1.00
July	1.40– 1.45	.90	.95– 1.00	.90– .95
October	1.40– 1.45	.80– 1.00	.95– 1.00	.90– .95

Indigo, Guatemala—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.65–$0.80	$0.65–$0.80	$0.65–$0.80		$3.00–$3.50
April	.65– .80	.65– .80	.65– .80		3.00– 4.50
July	.65– .80	.65– .80	.65– .80	$3.00–$3.50	3.00– 4.50
October	.65– .80	.65– .80		3.00– 3.50	3.00– 4.50

Month.	1917	1918	1919	1920
January	$3.00–$4.50	$2.25–$2.50	$2.25–$2.75	$2.00–$2.25
April	3.00– 3.25	2.25– 2.50	2.25– 2.75	2.00– 2.25
July	3.00– 3.25	2.25– 2.50	2.00– 2.25	2.25– 2.50
October	3.00– 3.25	2.25– 2.75	2.00– 2.25	1.90– 2.00

Indigo, Manila—Prices wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918	1919	1920
January		$0.70–$0.80	$1.30–$1.40
April		.70– 80	1.30– 1.40
July	[1] $0.80	1.30– 1.40	1.30– 1.40
October	$0.70– .80	1.30– 1.40	1.30– 1.40

[1] Not listed previously.

Indigo, Oudes—Prices wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918	1919	1920
January		$2.25–$2.75	$2.25–$2.75
April	$2.75–$2.90	2.25– 2.75	2.25– 2.75
July	2.25– 2.50	2.25– 2.75	2.00– 2.25
October	2.25– 2.75	2.25– 2.75	2.00– 2.25

Indigo, J (synthetic)—Prices wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.18–$0.20	$0.18–$0.20	$0.18–$0.20	$0.65	$1.35
April	.18– .20	.18– .20	.18– .20	.65	1.90
July	.18– .20	.18– .20	.18– .20	.65	2.00
October	.18– .20	.18– .20	.65	.65	1.35

Month.	1917	1918	1919	1920
January	$1.50	[1] $1.25	[1] $1.15–$1.25	$0.85
April				
July				
October		$1.15– 1.25		$0.95– 1.10

[1] 20 per cent paste.

Indigo, medium—Prices wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915 [1]	1916 [1]	1917 [1]	1918 [1]	1919 [1]	1920 [1]
	Cents.	*Cents.*	*Cents.*						
January	75	75	75						
April	75	75	75						
July	75	75	75						
October	75	75							

[1] Not listed.

Indigo, high-grade—Prices wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915 [1]	1916 [1]	1917 [1]	1918 [1]	1919 [1]	1920 [1]
	Cents.	*Cents.*	*Cents.*						
January	80–95	80–95	80–95						
April	80–95	80–95	80–95						
July	80–95	80–95	80–95						
October	80–95	80–95							

[1] Not listed.

Indigo extract—Prices wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	6–10	6–10	6–10	6–10	50–60	30–45	26–30	26–30	18–23
April	6–10	6–10	6–10	6–10	60	30–45	26–30	23–26	18–23
July	6–10	6–10	6–10	50–60	35–40	30–45	26–30	23–26	18–23
October	6–10	6–10	6–10	50–60	30–45	30–45	26–30	23–26	

Indigo—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1883	Sched A.	Indigo, extracts of, and carmined	10 per centum ad valorem.
1890	29	Indigo, extracts or pastes of, coal-tar preparations	Three-fourths of 1 cent per pound.
		Carmined	10 cents per pound.
1890	614	Indigo	Free list.
1894	14	All coal-tar colors or dyes, by whatever name known, and not specially provided for in this act	25 per centum ad valorem.
1894	514	Indigo, and extracts or pastes of, and carmines	Free list.
1897	15	Coal-tar dyes or colors, not specially provided for in this act	30 per centum ad valorem.
		All other products or preparations of coal tar, not colors or dyes and not medicinal, not specially provided for in this act.	20 per centum ad valorem.
	80	Indigo	Free list.
1909	15	Coal-tar dyes or colors, not specially provided for in this section	30 per centum ad valorem.
		All other products or preparations of coal-tar, not colors or dyes and not medicinal, not specially provided for in this section.	20 per centum ad valorem.
1909	592	Indigo (inquiry on synthetic indigo)	Free list.
1913	514	Indigo, natural or synthetic, dry or suspended in water, and dyes obtained from indigo.	Do.
1916	Group III.	Natural alizarin and indigo, and colors, dyes, or color lakes obtained, derived, or manufactured therefrom.	30 per centum ad valorem.

LITMUS.

General Information.

Act of 1913, paragraph 536: Litmus, prepared or not prepared, free.

Description and preparation.—Litmus is closely related to archil. It is prepared from the same class of lichens, including the species *Lecanora tinctoria*, *L. Orinca*, and *Rocella tinctoria*. The lichens occur abundantly in Scandinavia and the French Pyrenees. Litmus is not a domestic product; our total consumption is imported.

In the preparation of litmus the same lichens may be used as in the case of archil, although other species are commonly employed. The

shredded or ground weed is allowed to ferment after addition of sodium or potassium carbonate solution. When a violet color develops, stale urine is added and the fermentation allowed to continue until the color is blue. It is also prepared with ammonium and sodium carbonate with access of air under control. The product is mixed with chalk or gypsum and sold as small cubes. In this process an air oxidation similar to the action in the preparation of archil takes place. In the case of litmus the oxidation proceeds one step beyond resulting in the formation of azolitmin, the coloring matter of litmus.

The principal coloring matter azolitmin is a reddish brown powder slightly soluble in water. It is a weak acid of red color, the salts of which are blue. Chemically it is closely related to orcein prepared from archil.

Uses.—Litmus is used as an indicator in chemistry for acids and alkalis. It has been used as a wine and a vinegar color.

Imports.—In the period 1910–1914 the value of the imports varied from $103 in 1910 to $378 in 1912. The maximum import was made in 1919 of $4,177.

Tariff history.—Litmus has been specifically mentioned on the free list as far back as 1883.

Tariff considerations.—As litmus, paragraph 536, archil, paragraph 564, and cudbear, paragraph 469 (act of 1913), are closely related, they might be grouped in the same paragraph.

Litmus, prepared or not prepared—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity	Actual and computed ad valorem rate.
1910	Free		$103			
1911	do		277			
1912	do		378			
1913	do		216			
1914	do		263			
1915	do		59			
1916	do		280			
1917	do		648			
1918	do		44			
1919	do		4,177			

Litmus—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	545	Litmus, prepared or not prepared	Free.
1890	637	do	Do.
1894	539	do	Do.
1897	602	do	Do.
1909	615	do	Do.
1913	536	do	Do.

COURT AND TREASURY DECISIONS.

Litmus paper is not exempt from duty as litmus, but dutiable as bibulous paper under paragraph 323 of the act of 1913, but if in book form as a manufacture of bibulous paper under the same paragraph (T. D. 36274 and 36519, of 1916).

LOGWOOD EXTRACT.

SUMMARY.

The products here included are: (1) Crude logwood, known as "stick" logwood; (2) logwood extract derived from logwood by water extraction.

Logwood extract is used in dyeing wool, silk, leather, cotton, hair, fur, wood, and other materials in conjunction with metallic mordants. It is a valuable weighting agent for silk, and is also used in the manufacture of inks. Logwood does not grow in the United States. The American and European supply is imported from West Indies, Central America, and Mexico.

The United States production of logwood extract in 1914 amounted to 29,000,000 pounds, valued at a little over $1,300,000. In 1918 logwood extract was exported to Europe, South America, and Japan to the value of $2,339,480.

Some competition is offered by the extraction plants in Jamaica, with development, these plants could supply the American market.

In the United States there are eight large extract manufacturers who usually manufacture other dye extracts and tanning materials. They are located along the Atlantic seaboard, including the following States: Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Maryland, Virginia, and Alabama.

By the act of 1894 logwood extract was assessed a duty of 10 per cent ad valorem. In 1897 this ad valorem rate was changed to a specific rate of seven-eighths of 1 cent per pound. The act of 1913 reduced this rate to three-eighths of 1 cent per pound. Crude logwood has been shown on the free list as far back as the act of 1883.

Logwood extract and other dyewood extracts—Summary table.

[Paragraph 30.]

Fiscal year.	Domestic production.	Imports for consumption.	Domestic exports.	Ratio to production.	
				Imports.	Exports.
	Pounds.	*Pounds.*		*Per cent.*	*Per cent.*
1910	[1] 22,317,248	2,937,626	.....	.....	.....
1911	.....	3,599,604	.....	.....	.....
1912	.....	2,463,422	.....	.....	.....
1913	.....	2,258,206	.....	.....	.....
1914	28,989,962	1,228,178	.....	.....	.....
1915	.....	2,061,368	.....	.....	.....
1916	.....	2,852,787	.....	.....	.....
1917	.....	1,147,488	.....	.....	.....
1918	.....	215,950	.....	.....	.....

Fiscal year.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
			Per pound.	*Per cent.*
1910	$187,124	$25,704	$0.06	13.74
1911	197,280	31,496	.05	15.97
1912	112,552	21,554	.05	19.15
1913	111,575	19,759	.05	17.71
1914	77,119	7,142	.06	9.25
1915	144,207	7,730	.07	5.38
1916	316,872	9,947	.12	3.14
1917	164,727	4,327	.14	2.62
1918	24,698	810	.11	3.26

[1] 1909.

Logwood in crude state—Summary table.

[Paragraph 624.]

Fiscal year.	Domestic production.	Imports for consumption.	Domestic exports.	Ratio to production.	
				Imports.	Exports.
		Tons.		*Per cent.*	*Per cent.*
1910		31,269			
1911		35,340			
1912		39,924			
1913		36,952			
1914		30,172			
1915		54,704			
1916		134,819			
1917		121,762			
1918		55,354			

Fiscal year.	Value (imports for consumption.)	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
			Per ton.	*Per cent.*
1910	$353,311	Free	$11.30	
1911	424,123	...do	12.00	
1912	481,384	...do	12.06	
1913	475,484	...do	12.87	
1914	379,754	...do	12.59	
1915	722,410	...do	13.20	
1916	3,437,388	...do	25.50	
1917	4,127,031	...do	33.89	
1918	1,175,049	...do	21.22	

General Information.

Paragraph 624: * * * and articles in a crude state used in dyeing or tanning, free. (This provision covers crude logwood.)

Paragraph 30: Extracts and decoctions of * * * logwood * * * three-eighths of 1 cent per pound.

DESCRIPTION.

Crude logwood.—Logwood, the most important of the natural dyewoods, is obtained from the heartwood of a large and rapidly growing tree (*Hematoxylin campechianum*) indigenous to the soil of Central and South America, Mexico, and the islands of the West Indies.

The trees, known by the natives as campeache, are usually found at the foot of a mountain range and growing up the sides to an altitude of 2,200 feet. The wood obtained in the valleys is a dark red, while mountain wood is a reddish brown. The mountain wood is considered more valuable, due to the fact that it gives a larger amount of extract per ton of wood. The value of crude logwood depends primarily upon the percentage of the coloring matter present in the wood.

"Virgin wood" contains a higher percentage of the coloring matter, hematoxylin, than wood that is cut every few years, known as cropwood or plantation wood. In Jamaica there is an increasing quantity of "bastard wood," an unmerchantable variety that is practically devoid of coloring matter.

Logwood is usually imported into this country in the form of rough logs varying in length and shape. The crude wood is generally car-

ried on sailing vessels. There is a weight shrinkage of about 7 per cent in transit from the West Indies to the United States. No attempt is made by the original cutter to sort or classify the crude logwood, and it is sold "as it runs" to the logwood speculator, who in turn sells it to the foreign logwood buyer. In this way the wood generally passes through two or three hands before reaching the buyer from the United States. The importers buy this wood on the basis of the kilo (2.204 pounds); it is purchased in the United States on the basis of the long ton (2,240 pounds).

Logwood logs are not sold as such to the dyers, but are first reduced to small chips or rasped to a powder by the extract manufacturers. The freshly chipped wood contains from 5 to 10 per cent by weight of a colorless compound called "hematoxylin," from which the coloring matter is obtained by processing. Hematoxylin acts as a weak acid. It combines with metallic bases to form salts which rapidly absorb oxygen to form the hematites.

Logwood extracts.—Formerly large quantities of logwood were sold direct to the consumer in the chipped or rasped form. Since the development of the extract industry on a large scale with practically complete standardization of its products, the consumer has found it more convenient and economical to use logwood in the form of an extract. Logwood extract is a product made by treating logwood chips with hot water and evaporating the resulting solution to a thick liquid or solid. The yield of extract is about 25 per cent of the weight of logwood in terms of 51° Tw. extract. Logwood extracts are usually sold as thick liquids in strengths of 51° Tw. (Logwood extract), and solid extracts, "solid logwood extract" and "crystals."

A chemically different product is obtained from "logwood extract" by a chemical process in which the coloring matter haematoxylin is oxidized to a compound known as "hematine." There are several commercial grades of hematine including the liquid extracts of 52 Tw. and 42 Tw. In addition to these grades there are several solid forms known as "hematine solid," "hematine crystals," and "crystalline hematine paste." These latter grades are also known under such names as "oxidized logwood extract," "logwood extract for wool."

Although oxidized and unoxidized extracts are used on silk wool, leather, and cotton, the oxidized extract "hematine" is chiefly employed on wool.

Uses.—Logwood is the most useful dyestuff for the dyeing of blacks. It is used for blacks on silk, wool, leather, cotton, fur, straw, and in the preparation of inks and color lakes for wall paper printing. It finds considerable application also as a darkening constituent in grays, tans, browns, and compound shades, and has a small use for production of blues. Salts of chromium, copper, and iron serve as mordants in logwood blacks. Previous to the introduction of coal-tar dyes, logwood was used in the production of a variety of blues and purples. At present logwood is used almost exclusively in the production of blacks and as a darkening constituent in compound shades.

On animal fibers the underhand solid blueness and over bloom which logwood blacks retain in artifical light have made it the standard black. The synthetic dyes have not been able to fully duplicate these qualities. On wool it offers keen competition to the coal-tar colors. On silk it is the most important black. Silks will absorb

over 200 per cent of extract, thus serving as a weighting agent. A properly dyed black on silk increases the durability and resistance to wear and tear. On cotton logwood blacks are of poor fastness and are used only for cheap blacks in dyeing and calico printing. The sulphur blacks, "aniline black" and certain "developed blacks" have displaced it for fast shades.

Up to the period of the great war the coal-tar dyes were gradually displacing logwood, due to their lower labor cost in application. In addition certain coal-tar dyes had greater fastness for special uses. The extract manufacturers are meeting this labor cost competition by new extracts which dye and mordant in one operation. Logwood, in common with the other natural dyes, was subjected to the most unscrupulous competition by the German dye firms. It apparently was their purpose to annihilate the natural-dye industry.

DOMESTIC PRODUCTION.

The manufacture of logwood extract is the most important part of the natural-dye industry both in quantity produced and value of the product.

Of the value of natural dyestuffs in 1914, logwood extract constituted over 70 per cent. Of the total value of all dyestuffs, including coal-tar dyes, logwood constituted 18 per cent. In 1914 the total value of the natural dyestuffs was $1,862,162, of which logwood represented $1,311,966. In quantity the natural dyestuffs produced in the same year totaled 45,887,938 pounds; of this quantity 28,989,962 pounds were logwood.

Raw materials.—The raw material of this industry is crude or "stick" logwood. It is obtained principally from Haiti, Jamaica, and since about the year 1914, it has been imported from Mexico in increasing quantities. Smaller amounts are also obtained from San Domingo, British Honduras, and other parts of Central and South America and Cuba. The American producer is, therefore, well located in regard to the supply of raw materials.

Haiti furnishes about one-half of the logwood imported into this country. The export duty in Haiti is $3.20 per ton on crude logwood. Shipments from Mexico have been somewhat hampered on account of the internal troubles and high freight rates. The bulk of the wood out in British Honduras goes to Europe.

Equipment.—The machinery used for chipping and extracting the wood and for the extract evaporation is of standard American manufacture.

The wood is reduced to small pieces by the "wood hog," a very heavy V or spool shaped cylinder containing staggered knives. To complete the disintegration of the wood the product passes through a shredder. This consists of several dozen loose hammers revolved on a common shaft. The wood chipper is also used. This is a high-speed revolving disk on which are bolted heavy steel knives. Extraction is carried out in closed copper autoclaves with steam under pressure. For evaporation of the extract double and triple effect vacuum evaporators are employed.

Method of manufacture.—In the preparation of extract the unaged wood is used, because the haematoxylin is soluble in water, while the product of ageing or oxidation of hæmatin is not readily soluble.

The sticks or logs are sent through the "wood hog" and shredder or cut across the grain into chips of one-eighth inch thickness. These are packed in the extractor and water run in. The American process extracts, usually, under pressure of 20–30 pounds. While higher pressures are used, excessive pressure injures the tinctorial value of the product. This is more economical and gives more complete exhaustion than the old French open-vat process.

Several extractors connected form a unit similar to the beet-sugar diffusion apparatus. Any unit can be disconnected for discharging and refilling without interfering with the operation of the other members of the unit.

The resulting thin extract is run into open vats, where much wood fiber and resinous material separates. The settled liquor is then evaporated under reduced pressure, in a triple-effect evaporator, to a density of 51° Tw. At this point it has a molasses consistency and it is run into barrels for shipment.

For the production of a solid extract, the final evaporation is carried out in a single-effect evaporator similar to the strike pan of the sugar industry. On cooling, the concentrated extract solidifies to the solid extract of commerce.

Hæmatin extract is made by treating logwood extract with sodium dichromate or other suitable oxidizing agents or by blowing air through the extract to which alkali has been added. A chemical change takes place whereby the hæmatoxylin is converted into hæmatin. On further evaporation, this liquid forms solid hæmatin extract or hæematin crystals. It is shipped in barrels or boxes lined with paper to prevent leakage. A product called crystalline hæmatin paste has recently been introduced; it is a viscous extract containing minute crystals of hæmatin in suspension. The details of its preparation are kept secret.

Organization.—Establishments manufacturing logwood extracts are usually producers of other wood extracts for dyeing and tanning. The bulk of the business in this country is confined to eight large producers and several smaller firms recently organized for the war trade.

As logwood extract is only one of the many products made and in many cases is a small part of the production in quantity and value, the actual capital invested in its production would be difficult to ascertain.

Geographical distribution.—The plants of the lowgood extract manufacturers are located in the Eastern States, within convenient distance from ports on the Atlantic seaboard, including the following: Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Maryland, Virginia, and Alabama. The American extractors are more favorably located than those of Europe, as they are nearer to the West Indies, the source of raw materials.

History of the industry.—In general, the logwood and natural dyewood industry might well be called one of the first American industries. Certain pioneer establishments have been in continuous operation since the year 1794. During the few years prior to the great war the industry had not increased, as the coal-tar dyes were gradually displacing logwood. As previously indicated this was due to unscrupulous competition from the German dye firms and the lower labor cost for dyeing coal-tar dyes and for certain uses the greater

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fastness of the synthetic dyes. During the acute shortage of dyes in 1916 the industry enjoyed the greatest prosperity in its history, as shown in the domestic production table. This widespread use of logwood gave the industry an excellent opportunity to establish the merits of its products, and resulted in considerable development in the manufacture of extracts.

Domestic production and consumption.—Previous to the war the domestic production of logwood extract was decreasing; in 1899, 39.2 million pounds were produced; in 1909, 22.3 million pounds, corresponding to a decrease of 43.2 per cent in 10 years. The production of 1914 was 29.9 million pounds.

In 1916, if all the imported crude wood was manufactured into extract, the calculated quantity would equal 75,000,000 pounds of 51° extract. During that same year the shortage of coal-tar dyes caused an unprecedented demand for natural dyes, resulting in four times the prewar imports of crude logwood, and a fourfold increase in the manufacture and use of the extract.

In 1913 a total of about 1,500,000 pounds of logwood[1] was consumed in the United States by 23 cotton mills, 5 woolen mills, 8 silk mills, and 21 dye and finishing establishments, to the value of $108,291. In 1916 the same plants consumed over six million pounds of logwood,[1] valued at about $1,800,000. This is indicative of the increased use of this natural dye because of the coal-tar dye shortage during the early years of the war. This statement does not indicate the number of the mills using logwood nor the value of the product consumed.

Domestic exports.—Exports of the extracts are not shown separately previous to 1918 in "Commerce and Navigation." Due to the world dye shortage, the extractors in 1918 enjoyed a large export trade, totaling $2,339,480 in value. France received 31 per cent, Great Britain 22 per cent, Japan 20 per cent, the remainder going to Italy, South America, Canada, and China.

In 1919[2] the total value of the logwood extract exports was $1,226,154. France received 48.6 per cent, England 22.2 per cent, Canada 9.8 per cent, and Italy 4.7 per cent, the remainder being widely distributed to a number of countries.

The quality of the American extract is equal or superior to any of the European products. In Europe their extracts are frequently adulterated with glucose, molasses, dextrin, salt, starches, and other inferior extracts.

Foreign production.—Data are not availble showing the production of logwood extract in any of the foreign countries. In the latest figures available Germany imported about six times the quantity of extract exported. England and France are large producers of extract, the latter having an export trade. Due to the war dye shortage England in 1914 imported a quantity of crude logwood equal in terms of 51° Tw. extract to about 10½ million pounds.

In 1914 the United States imported from Jamaica[3] 14,747 packages of logwood extract, valued at $525,597. In 1915, 1,365 packages, valued at $34,749. In 1916, 1,436 packages, valued at $89,732. The weight of a package[3] is 425 pounds gross, 350 pounds net.

[1] These figures are mostly for extract.
[2] Commerce Report No. 147, June 23, 1920.
[3] Commerce Reports, Friday, May 3, 1918, No. 104, p. 455.

It is reported that the Jamaica plants have a production capacity requiring about 45,000 tons of logwood per year, and that Haiti has a consumption of about 5,000 tons of stick logwood per year. The Haiti plant was recently destroyed by fire.

IMPORTS.

Crude logwood.—In the period 1910 to 1915 the imports for consumption of crude logwood varied from 30 to 39 thousand tons per year. In 1915 the American imports were reduced by the embargo of the English Government on logwood from Jamaica and British Honduras. Due to the dye shortage, the imports increased in 1916 to 134,819 tons. This is the maximum importation for any year in the history of the industry. In 1918 the imports were less than half the 1916 tonnage. This decrease was largely due to the increased production of coal-tar dyes in the United States and England, following the development of the coal-tar industries in these countries.

The imports of logwood and other dyewood extracts have been fairly constant, averaging about 2½ million pounds per year from 1900 to 1914. In 1914 about half the normal supply was received.

In the later war period, 1917–18, import restrictions, high freight rates, and allocation of cargo space decreased imports of all dyewood extracts to 215,950 pounds, only 8 per cent of those of 1916.

Specific data on imports of logwood extract are not given. Most of the imported extract is made in Jamaica, where it is manufactured by several companies, including two plants owned in America, whose capacity is below the needs of our domestic consumers.

The imports for consumption of logwood and other dyewood extracts for 1910 and 1914 amounted to 13 and 4 per cent, respectively, of the domestic production of logwood extract.

Tariff history.—Crude logwood has been on the free list as far back as the tariff act of 1883.

In the act of 1894 logwood extracts were assessed an ad valorem duty of 10 per cent. In 1897 this duty was changed to a specific rate of seven-eighths of 1 cent per pound. By the act of 1913 it was reduced to three-eighths of 1 cent per pound.

Prices.—During 1912 and 1913 the crude or stick logwood sold for $15 a ton. The solid extract for three years, 1912, 1913, and 1914, was 6 cents a pound, while the liquid 51° Tw. extract during the same period was 5 cents a pound. The war dye shortage caused an increase in price; from 5–10 cents per pound in the first quarter of 1915 to 50–80 cents per pound in the first quarter of 1916, on 51° extract. On crude logwood, the increase in price was: From $15.75–$20 per ton in the first quarter of 1914 to $55–$100 per ton in the second quarter of 1916, due to an embargo on logwood from Jamaica and British Honduras.

Early in the year 1919 shipping became available for moderate supplies of logwood. Sailing vessels were used to bring supplies to this country from the West Indies. With the gradual return of troops from Europe tonnage was released for export and import business and extract makers began to feel sure they would be able to secure all the dyestuffs they needed. The price of logwood sticks dropped considerably. About the middle of April, however, pressing demands for direct allocation of ships were made in certain

quarters. The extract makers declared that unless the raw materials soon arrived they could not take care of this large and prosperous industry. Their complaints were ignored by officials in charge of the allocations and rules were put into effect which made it practically impossible to secure West Indian products. The few vessels that came were forced to take on cargo at Rio de Janeiro with the result that they had almost no space left for dyewoods when they reached the West Indies, a procedure which necessarily made prices of both the wood and extracts rise to higher levels. The prices have receded to $30–$32 per ton for crude logwood and 12–14 cents per pound for the extract, in the last quarter of 1919. Through 1920 the prices of crude logwood have been three times as great as in the prewar period on account of lack of supplies, hence the extract prices remain high in proportion.

In Great Britain the price of stick logwood in the first quarter of 1913 was $38.93 per long ton, and for the first quarter of 1918 it was $97.33 per long ton. In the United States the prices for the same periods were $15.75 and $41.42, respectively.

Competitive conditions.—With further development Jamaican producers would be able to meet demands of the American consumer. They have the advantage of favorable location to the logwood forests and thereby affect an economy in freight. The imported solid extract would on account of freight economy offer greater competition than the liquid to our domestic product. Labor is cheaper in the West Indies than in the United States. The technical men necessary for the operation of extract plants are difficult, however, to secure for West Indies plants.

French-made extract is reported to offer serious competition to American-made product in the Japan market. England, France, Germany, Switzerland, and Italy all manufacture logwood extract for the European and export trade. Foreign coal tar dyes are competitive to logwood.

Tariff considerations.—The removal of the duty on extract would have a tendency to develop the industry in Jamaica and other islands of the West Indies. It would also favor the importation of extract rather than the crude logwood. A duty on extracts with duty-free logs favors the domestic production of logwood extract.

Logwood extract—Production in United States—"Official source."

[Paragraph 30.]

["Federal Census," Census of Manufactures, Table 101.[1]]

Year.	Quantity.	Value.
	Pounds.	
1899	39,252,743	$1,485,971
1904	29,799,606	1,472,047
1909	[2] 22,317,248	991,974
1914	[3] 28,989,962	1,311,966

[1] The figures do not include establishments which manufactured and consumed the product in their own plants, but only those establishments that offered the product for sale.
[2] Six establishments.
[3] Nine establishments.

Logwood—Imports of crude logwood into Great Britain.[1]

Years.	Quantity.	Value.
	Long tons.	
1909	4,985	$116,241
1910	10,867	204,636
1911	13,484	274,130
1912	5,679	141,873
1913	9,629	246,736
1914	9,343	248,031
1915	5,947	203,069
1916	18,679	1,169,128
1917	11,224	865,760

[1] Great Britain Trade, 1917.

Imports and exports of logwood extract—Germany.[1]

	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Imports of	3,334,458	$218,906	4,382,965	$302,752	5,378,563	$363,493
Exports of	1,393,087	90,278	1,205,475	91,231	1,519,410	111,716

	1912		1913	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Imports of	5,877,684	$422,805	6,139,370	$451,865
Exports of	1,212,750	92,660	1,239,647	100,044

[1] Vierteljahrsheft zur Statistik des Deutschen Reichs, 1914.

Logwood in crude state—Imports by countries by fiscal years.

[Par. 624, free.]

Imported from—	1912		1913		1914	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
British Honduras	559	$8,944	2	$34	.....	.....
Mexico	704	7,584	295	3,660	493	$8,773
Jamaica	17,179	235,936	18,771	262,350	19,884	269,272
Dominican Republic	2,282	27,153	1,269	18,677	239	4,410
Haiti	18,649	193,512	15,607	184,315	9,446	95,609
All other	198	3,854	1,083	7,880	.....	.....
Total	39,571	476,983	37,027	476,916	30,062	378,064
Calculated price per ton	.....	12.00	.....	12.75	.....	12.50

Imported from—	1915		1916		1917		1918	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
British Honduras	.....	.....	1,486	$55,319	1,477	$49,865	.....	.....
Mexico	4,534	$92,170	18,143	531,483	22,250	829,608	2,580	$72,424
Jamaica	29,247	378,886	45,052	1,162,554	27,960	1,118,334	19,006	435,612
Dominican Republic	2,006	19,827	3,988	111,302	8,963	221,718	4,439	75,216
Haiti	18,495	212,264	64,419	1,516,888	58,722	1,800,397	25,273	459,896
All other	777	39,087	1,541	60,152	3,422	117,478	729	23,307
Total	55,059	742,234	134,629	3,437,698	122,794	4,137,400	52,027	1,066,455
Calculated price per ton	.....	13.30	.....	25.60	.....	34.00	.....	.....

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Logwood in crude state—Imports for consumption—Revenue.

[Par. 624. Free.]

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity calculated.	Actual and computed ad valorem rate.
		Tons.				
1909	Free	17,873	$166,371		$9.31	
1910	do	31,289	353,311		11.30	
1911	do	35,340	424,123		12.00	
1912	do	39,924	481,384		12.06	
1913	do	36,952	475,484		12.87	
1914	do	30,172	379,754		12.57	
1915	do	54,704	722,410		13.20	
1916	do	134,819	3,437,388		25.50	
1917	do	121,762	4,127,031		33.89	
1918	do	55,354	1,175,049		21.22	
1919	do	20,871	412,952		19.79	

Logwood extract and other dyewood extracts—Imports for consumption—Revenue.

[Par. 30.]

Fiscal year.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity (calculated).	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	⅛ cent per pound	2,937,626	$187,124	$25,704	$0.06	13.74
1911	do	3,599,604	197,280	31,496	.05	15.97
1912	do	2,463,422	112,552	21,554	.05	19.15
1913	do	2,258,206	111,575	19,759	.05	17.71
1914	do	507,511	27,282	4,440	.05	16.28
1914	⅛ cent per pound	720,667	49,837	2,702	.07	5.42
1915	do	2,061,368	144,207	7,730	.07	5.36
1916	do	2,652,787	316,872	9,947	.12	3.14
1917	do	1,147,448	164,711	4,315	.14	2.61
1917 [1]	⅛ cent per pound —20 per cent.	40	16	12	.40	7.50
1918	⅛ cent per pound	215,950	24,698	810	.11	3.28
1919	do	265,774	51,041	997	.19	1.95

[1] Reciprocity treaty with Cuba.

Logwood extract—Domestic exports (fiscal year).

Exported to—	1918 [1]	
	Quantity.	Value.
	Pounds.	
France		$727,998
England and Scotland		524,610
Japan		483,100
Italy		125,644
South America		126,238
Canada		99,640
China		68,844
All other		183,406
Total		2,339,480

[1] Not shown separately prior to 1918.

Logwood, sticks—Prices per ton (wholesale).

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January..	$15–$20	$15–$20	$15.75–$20	$18–$20	$24–$30	$25–$38	$36–$40	$45–$50	$36–$40
April.....	15– 20	15– 20	15– 20	18– 20	55–100	25– 42 30– 42	36– 38	36–	(1)
July.....	15– 20	15– 20	15– 20	24– 30	55– 65	30– 35	45– 50	25– 50	47– 52
October..	15– 20	15– 20	18– 20	24– 30	35– 45	37– 43	[1] 45	30–[2] 32	47– 52

[1] Nominal. [2] Haitian.

Logwood, roots—Prices per ton.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January...	$11–$14	$11–$14	$11–$14	$12–$15	$18	$28–$35	$30–$40	(1)	[4] $45–$47
April.....	11– 14	11– 14	11– 14	12– 15	70–100	28– 35	35– 40	.....	(1)
July.....	11– 14	11– 14	[2] 11– 14	18–	70– 80	28– 35	[3] 45– 50 45	.....	(1)
October...	11– 14	11– 14	12– 15	18–	40	35– 40	(1)	.....	(1)

[1] Nominal. [2] August. [3] West Indian stick. [4] Black River, Jamaica.

Logwood, Jamaica—Prices per ton, current, wholesale (mean of high and low, beginning of month).

[From British Trade Journal.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January.....	$20.68	$23.72	$23.12	$23.72	$40.13	(1)	(1)	$97.40	$82.79
February.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	87.66	90.09
March.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	77.92	90.09
April.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	73.04	90 09
May.....	23.12	26.77	23.72	23.72	40.13	(1)	(1)	73.04	97.40
June.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	73.04	97.40
July.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	73.04	97.40
August.....	23.12	23.72	23.72	23.72	40.13	(1)	(1)	75.48	102.28
September.....	25.55	23.72	23.72	23.72	40.13	(1)	(1)	75.48	.....
October.....	23.72	23.72	23.72	23.72	40.13	(1)	(1)	75.48	.....
November.....	23.72	23.72	23.72	23.72	70.62	(1)	97.40	73.04	.....
December.....	23.72	23.72	23.72	40.13	70.62	(1)	97.40	73.04	.....

[1] Not quoted.

Logwood, St. Domingo—Prices per ton, current, wholesale (mean of high and low, beginning of month).

[From British Trade Journal.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January.....	20.68	23.72	23.72	23.72	34.09	70.62	(1)	(1)	(1)
February.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
March.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
April.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
May.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
June.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
July.....	23.12	23.72	23.72	23.72	34.09	70.62	(1)	(1)	(1)
August.....	23.12	23.72	23.72	23.72	34.09	(1)	(1)	(1)	(1)
September.....	27.37	23.72	23.72	23.72	34.09	(1)	(1)	(1)	(1)
October.....	23.72	23.72	23.72	23.72	34.09	70.62	(1)	(1)	(1)
November.....	23.72	23.72	23.72	23.72	70.62	70.62	(1)	(1)	(1)
December.....	23.12	23.72	23.72	34.09	70.62	70.62	(1)	(1)	(1)

[1] Not quoted.

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Logwood, Campeachy—Prices per ton, current, wholesale (mean of high and low, beginning of month).

[From British Trade Journal.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	31.63	32.24	32.24	32.34	53.57	70.62	(1)	97.40	77.92
February	30.42	32.24	32.24	32.24	53.57	70.62	70.62	87.66	90.09
March	30.42	32.24	32.24	32.24	53.57	70.62	70 62	87.66	90.09
April	30.42	32.24	32.24	32.24	53.57	70.62	70.62	73.04	90.09
May	30.42	32.24	32.24	32.24	53.57	70.62	70.62	73.04	97.40
June	30.42	32.24	32.24	32.24	53.57	70.62	70.62	73.04	97.40
July	30.42	32.24	32.24	32.24	53.57	70.62	(1)	75.48	97.40
August	30.42	32.24	32.24	32.24	53.57	(1)	(1)	75.48	102.27
September	30.42	32 24	32.24	32.24	53 57	(1)	(1)	77.92	.....
October	31.02	32.24	32.24	32.24	53.57	70.62	(1)	77.92	.....
November	32.24	32.24	32.24	32.24	70.62	70.62	97.40	73.04	.....
December	32.24	32.24	32.24	53.57	70.62	70.62	97.40	77.92	.....

[1] Not quoted.

Logwood, Honduras—Prices per ton, current, wholesale (mean of high and low, beginning of month).

[From British Trade Journal.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	$28.59	$30.42	$31.33	$31.35	$41.40	$70.62	(1)	$121.75	$97.40
February	28.59	30.42	31.33	31.35	41.40	70.62	$70.62	97.40	97.40
March	28.59	30.42	31.33	31.35	41.40	70.62	70.62	97.40	97.40
April	28.59	30.42	31.33	31.35	41.40	70.62	70.62	97.40	97.40
May	28.59	30.42	31.33	31.35	41.40	70.62	70.62	97.40	97.40
June	28.59	30.42	31.33	31.35	41.40	70.62	70.62	97.40	97.40
July	28.59	30.42	31.33	31.35	41.40	70.62	(1)	97.40	97.40
August	28.59	31.33	31.33	31.35	41.40	(1)	(1)	97.40	102.28
September	28.59	31.33	31.33	31.35	41.40	(1)	(1)	97.40	.....
October	29.81	31.33	31.33	31.35	41.40	70.62	(1)	97.40	.....
November	29.81	31.33	31.33	31.35	70.62	70.62	121.75	97.40	.....
December	29.81	31.33	31.33	41.40	70.62	70.62	121.75	97.40	.....

[1] Not quoted.

Logwood, chips.—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	1¼–1½	1½–1¾	1¼–1½	1½–1¾	4– 6	2½–5	2½–3½	3–5	4½–6
April	1½–1¾	1½–1¾	1¼–1½	1¼–1½	15–18	3 –5	2½–3½	3–5	5 –6
July	1¼–1½	1½–1¾	1½–1¾	2 –2½	9– 9½	3 –5	3½–6	3–5	5 –6
October	1¼–1½	1¼–1½	1¼–1½	4 –6	4– 5	2½–3½	4 –6	3–5	5 –6

Logwood extract, liquid, 42°—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	4–6	4–6	4–6	4–6	50	10–16	8 –11	9½–10	.....
April	4–6	4–6	4–6	4–6	60	10–16	8 –11	9½–10½	.....
July	4–6	4–6	4–6	5–7	35	10–16	8 –10	9½–10½	.....
October	4–6	4–6	4–6	50	25	10–16	9½–10½	.....	.....

Logwood, sticks—Prices per ton (wholesale).

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January..	$15–$20	$15–$20	$15.75–$20	$18–$20	$24–$30	$25–$38 25– 42	$36–$40	$45–$50	$36–$4
April.....	15– 20	15– 20	15– 20	18– 20	55–100	30– 42	36– 38	36–	(1)
July.....	15– 20	15– 20	15– 20	24– 30	55– 65	30– 35	45– 50	25– 50	47– 5
October..	15– 20	15– 20	18– 20	24– 30	35– 45	37– 43	[1] 45	30–[2]32	47– 5

[1] Nominal. [2] Haitian.

Logwood, roots—Prices per ton.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January...	$11–$14	$11–$14	$11–$14	$12–$15	$18	$28–$35	$30–$40	(1)	[4] $45–$47
April.....	11– 14	11– 14	11– 14	12– 15	70–100	28– 35	35– 40	.....	(1)
July.....	11– 14	11– 14	[2] 11– 14	18–	70– 80	28– 35	[3] 45– 50 45	.....	(1)
October...	11– 14	11– 14	12– 15	18–	40	35– 40	(1)	.....	(1)

[1] Nominal. [2] August. [3] West Indian stick. [4] Black River, Jamaica.

Logwood, Jamaica—Prices per ton, current, wholesale (mean of high and low, beginning of month).

[From British Trade Journal.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January.....	$20.68	$23.72	$23.12	$23.72	$40.13	(1)	(1)	$97.40	$82.79
February.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	87.66	90.09
March.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	77.92	90.09
April.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	73.04	90.09
May.....	23.12	26.77	23.72	23.72	40.13	(1)	(1)	73.04	97.40
June.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	73.04	97.40
July.....	23.12	23.12	23.72	23.72	40.13	(1)	(1)	73.04	97.40
August.....	23.12	23.72	23.72	23.72	40.13	(1)	(1)	75.48	102.28
September.....	25.55	23.72	23.72	23.72	40.13	(1)	(1)	75.48	.....
October.....	23.72	23.72	23.72	23.72	40.13	(1)	(1)	75.48	.....
November.....	23.72	23.72	23.72	23.72	70.62	(1)	97.40	73.04	.....
December.....	23.72	23.72	23.72	40.13	70.62	(1)	97.40	73.01	.....

[1] Not quoted.

Logwood, St. Domingo—Prices per ton, current, wholesale (mean of high and low, beginning of month).

[From British Trade Journal.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January.....	20.68	23.72	23.72	23.72	34.09	70.62	(1)	(1)	(1)
February.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
March.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
April.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
May.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
June.....	23.12	23.72	23.72	23.72	34.09	70.62	70.62	(1)	(1)
July.....	23.12	23.72	23.72	23.72	34.09	70.62	(1)	(1)	(1)
August.....	23.12	23.72	23.72	23.72	34.09	(1)	(1)	(1)	(1)
September.....	27.37	23.72	23.72	23.72	34.09	(1)	(1)	(1)	(1)
October.....	23.72	23.72	23.72	23.72	34.09	70.62	(1)	(1)	(1)
November.....	23.72	23.72	23.72	23.72	70.62	70.62	(1)	(1)	(1)
December.....	23.12	23.72	23.72	34.09	70.62	70.62	(1)	(1)	(1)

[1] Not quoted.

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Logwood, Campeachy—Prices per ton, current, wholesale (mean of high and low, beginning of month).

[From British Trade Journal.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	31.63	32.24	32.24	32.34	53.57	70.62	(1)	97.40	77.92
February	30.42	32.24	32.24	32.24	53.57	70.62	70.62	87.66	90.09
March	30.42	32.24	32.24	32.24	53.57	70.62	70.62	87.66	90.09
April	30.42	32.24	32.24	32.24	53.57	70.62	70.62	73.04	90.09
May	30.42	32.24	32.24	32.24	53.57	70.62	70.62	73.04	97.40
June	30.42	32.24	32.24	32.24	53.57	70.62	70.62	73.04	97.40
July	30.42	32.24	32.24	32.24	53.57	70.62	(1)	75.48	97.40
August	30.42	32.24	32.24	32.24	53.57	(1)	(1)	75.48	102.27
September	30.42	32.24	32.24	32.24	53.57	(1)	(1)	77.92	.....
October	31.02	32.24	32.24	32.24	53.57	70.62	(1)	77.92	.....
November	32.24	32.24	32.24	32.24	70.62	70.62	97.40	73.04	.....
December	32.24	32.24	32.24	53.57	70.62	70.62	97.40	77.92	.....

[1] Not quoted.

Logwood, Honduras—Prices per ton, current, wholesale (mean of high and low, beginning of month).

[From British Trade Journal.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	$28.59	$30.42	$31.33	$31.35	$41.40	$70.62	(1)	$121.75	$97.49
February	28.59	30.42	31.33	31.35	41.40	70.62	$70.62	97.40	97.40
March	28.59	30.42	31.33	31.35	41.40	70.62	70.62	97.40	97.40
April	28.59	30.42	31.33	31.35	41.40	70.62	70.62	97.40	97.40
May	28.59	30.42	31.33	31.35	41.40	70.62	70.62	97.40	97.40
June	28.59	30.42	31.33	31.35	41.40	70.62	70.62	97.40	97.40
July	28.59	30.42	31.33	31.35	41.40	70.62	(1)	97.40	97.40
August	28.59	31.33	31.33	31.35	41.40	(1)	(1)	97.40	102.28
September	28.59	31.33	31.33	31.35	41.40	(1)	(1)	97.40	.....
October	29.81	31.33	31.33	31.35	41.40	70.62	(1)	97.40	.....
November	29.81	31.33	31.33	31.35	70.62	70.62	121.75	97.40	.....
December	29.81	31.33	31.33	41.40	70.62	70.62	121.75	97.40	.....

[1] Not quoted.

Logwood, chips.—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	1¼–1½	1¼–1½	1¼–1½	1½–1¾	4– 6	2⅜–5	2½–3½	3–5	4½–6
April	1¼–1½	1¼–1½	1¼–1½	1¼–1½	15–18	3 –5	2½–3½	3–5	5 –6
July	1¼–1¼	1¼–1½	1¼–1½	2 –2½	9– 9¼	3 –5	3½–6	3–5	5 –6
October	1¼–1½	1¼–1½	1¼–1½	4 –6	4– 5	2¾–3½	4 –6	3–5	5 –6

Logwood extract, liquid, 42°—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	4–6	4–6	4–6	4–6	50	10–16	8 –11	9½–10	.....
April	4–6	4–6	4–6	4–6	60	10–16	8 –11	9½–10½	.....
July	4–6	4–6	4–6	5–7	35	10–16	8 –10	9½–10½	.....
October	4–6	4–6	4–6	50	25	10–16	9½–10½	.....	.....

Logwood extract, liquid, 51°.—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents*
January	5–10	5–10	5–10	5–10	50–80	15–20	14 –16	13–15	12–1
April	5–10	5–10	5–10	5–10	65–75	14–18	10 –11	11–13	15–1
July	5–10	5–10	5–10	6– 8	35–40	11–12	11½–12½	11–13	15–1
October	5–10	5–10	5–10	50–70	30–40	12–16	16 –18	12–14	15–1

Logwood extract, solid.—Prices, wholesale, per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	6–12	6–12	6–12	6–12	90	30 –35	19–26	23–25	17½–19
April	6–12	6–12	6–12	6–12	85	30 –35	19–26	20–22	23 –25
July	6–12	6–12	6–12	12	70–75	20 –25	19–21	20–22	25 –27
October	6–12	6–12	6–12	95	40–50	17½–19	22–24	20–22	25 –27

Logwood extract, crystals.—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	10–15	10–15	10–15	10–15	115	35–40	24 –27	25–30	20–22
April	10–15	10–15	10–15	10–15	95	35–50	20½–27	22–28	27–30
July	10–15	10–15	10–15	15	90	20–26	20½–27	22–26	30–31
October	10–15	10–15	10–15	120	55–60	20–26	24 –29	25–26	34–35

Wholesale prices of logwood in the United Kingdom and the United States, by quarters and years, 1913–1918.

[From International Price Comparisons, Department of Commerce, by W. C. Mitchell.]

[Per long ton.]

	Actual price.		Relative price.	
	United Kingdom (London).	United States (New York).	United Kingdom (London).	United States (New York).
1913	$38.93	$15.00	100	100
First quarter	38.93	15.00	100	100
Second quarter	38.93	15.00	100	100
Third quarter	38.93	15.00	100	100
Fourth quarter	38.93	15.00	100	100
1914	38.93	15.75	100	105
First quarter	38.93	15.00	100	100
Second quarter	38.93	15.00	100	100
Third quarter	38.93	15.00	100	100
Fourth quarter	38.93	18.00	100	120
1915	41.37	22.00	106	147
First quarter	38.93	18.00	100	120
Second quarter	38.93	22.00	100	147
Third quarter	38.93	24.00	100	160
Fourth quarter	48.67	24.00	125	160
1916	76.04	42.42	195	283
First quarter	68.94	31.33	177	209
Second quarter	77.86	63.33	200	422
Third quarter	77.86	50.00	204	333
rter	77.86	25.00	200	167

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Wholesale prices of logwood in the United Kingdom and the United States, by quarters and years, 1913–1918—Continued.

	Actual price		Relative price.	
	United Kingdom (London).	United States (New York).	United Kingdom (London).	United States (New York).
1917	$81.51	$31.67	209	211
First quarter	73.00	28 33	188	189
Second quarter	77.86	29.33	200	196
Third quarter	82.73	30.00	213	200
Fourth quarter	92 46	37.00	238	247
1918	97.33	41.42	250	276
First quarter	97.33	36.00	250	240
Second quarter	97.33	37.33	250	249
Third quarter	97.33	45.67	250	304
Fourth quarter	97.33	46.67	250	311

Logwood, crude—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty specific and ad valorem.
1890	492	Articles in a crude state used in dyeing or tanning not specially provided for in this act.	Free.
1894	386	.....do.....	Do.
1897	482	.....do.....	Do.
1909	499	.....do.....	Do.
1913	462	Tanning material: * * * and articles, in a crude state used in dyeing or tanning: all the foregoing not containing alcohol and not specially provided for in this section.	Do.

Logwood, extract—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Logwood and other dyewoods, extracts and decoctions of.....	10 per cent ad valorem.
1890	26	Extracts and decoctions of logwood and other dyewoods, extract of sumac, and extracts of barks, such as are commonly used for dyeing or tanning not specially provided for in this act.	½ cent per pound.
1894	18	Extracts and decoctions of logwood and other dyewoods, extracts of sumac, and extracts of barks, such as are commonly used for dyeing or tanning, not specially provided for in this act, and extracts of hemlock bark.	10 per cent ad valorem.
1897	22	Extracts and decoctions of logwood and other dyewoods, and extracts of barks, such as are commonly used for dyeing or tanning, not specially provided for in this act.	½ cent per pound.
1909	22	Extracts and decoctions of logwood and other dyewoods, such as are commonly used for dyeing or tanning, not specially provided for in this section.	Do.
1913	30	Extracts and decoctions of nutgalls, Persian berries, sumac, logwood, and other dyewoods, and all extracts of vegetable origin suitable for dyeing, coloring, or staining, not specially provided for in this section; all the foregoing not containing alcohol and not medicinal.	⅛ cent per pound.

MADDER.

[Paragraph 538, act of 1913—Free.]

General Information.

Paragraph 538, "Madder and munjeet, or Indian madder, ground or prepared, and all extracts of."

Description.—Madder is the pulverized root of the *Rubis tinctoria.* At one time it was the most important color excepting indigo. It is not raised in the United States.

Uses.—To-day the chief consumer of madder is the indigo dyer, using the wood vat for wool. Its chief function in this case is for a ferment. The large quantities of natural alizarin formerly used for cotton printing, turkey red dyeing, and for wool are now supplied by synthetic alizarin. This is now made in the United States.

The use of madder for dyeing turkey reds antidates the Christian era. Synthethic alizarin (alizarin is the active coloring principle of madder) has almost entirely displaced madder, on account of its purity, uniformity, and low cost.

The madder plant is a native of Asia; it was extensively cultivated in France, Italy, and Holland. To-day Dutch madder is the principle variety. The *Rubia tinctoria* is a perennial plant commercially propagated by shoots. The roots are gathered in the second or third years; after drying they are ground and stored for a long period. The true coloring matters, alizarin, with some purpurin and pseudo-purpurin, are formed by the decomposition of the glucoside rubian during this period of storage.

Alizarin, the active principle of madder, forms orange red crystals slightly soluble in hot water and readily soluble in alkaline solution with a red color. Madder gives with aluminum salts a pink to red color, with chromium salts bluish red to crimson, with iron salts reddish brown, and with tin salts red orange.

Madder is principally marketed as a ground root. Flowers of madder were prepared by treating madder with dilute sulphuric acid. Garancin was a product made by treating the madder with concentrate sulphuric acid.

Imports.—In the period 1909–1913 the annual imports varied from 30,602 pounds, valued at $2,803, to 45,430 pounds, valued at $4,206. In the war period, the shortage of synthetic alizarin increased the importation of madder. In 1917 the United States imported 78,852 pounds, valued at $12,472. This maximum dropped to 2,193 pounds, valued at $253, in 1918.

Prices.—The prewar price for madder was 12 to 14 cents per pound. This increased to 28 to 30 cents per pound in 1916. In 1919 this dropped to 20 to 25 cents per pound, returning in the last quarter to the highest war quotation, 28 to 30 cents per pound.

Tariff history.—Madder has been specifically shown on the free list since 1883.

Madder or munjeet, or Indian madder, ground or prepared—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				
1909	Free	37,910	$3,019		$0.079	
1910	do	30,709	2,312		.075	
1911	do	45,430	4,206		.093	
1912	do	41,957	2,834		.068	
1913	do.[1]	30,602	2,803		.092	
1914	do	47,068	3,817		.081	
1915	do	29,327	3,524		.120	
1916	do.[1]	68,381	9,037		.132	
1917	do	78,852	12,472		.158	
1918	do	2,193	253		.115	
1919	do					

[1] Extracts of madder: 1913, 2,154 pounds, valued at $233; 1916, 11,458 pounds, valued at $619. Not separately listed in other years.

Madder or munjeet, or Indian madder—Reexports.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				
1909	Free	1,363	$115		$0.084	
1913	do	2,154	233		.108	
1914	do	11,458	619		.054	

Madder, Dutch—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	12½-14	12-14	12-14	14-20	24-25	28-30	26-30	27-29	28-30
April	12½-14	12-14	12-14	20-22	28-30	26-30	26-30	25-30	28-30
July	12½-14	12-14	12-14	17-19	28-30	26-30	26-30	20-25	25-28
October	12 -14	12-14	14-20	17-19	28-30	26-30	26-30	28-30	

Madder or munjeet, or Indian madder—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty specific and ad valorem.
1883	[1] 2503	Madder and munjeet, or Indian madder, ground or prepared, and extracts of.	Free.
1890	639	Madder and munjeet, or Indian madder, ground or prepared, and all extracts of.	Do.
1894	541	do	Do.
1897	604	do	Do.
1909	617	do	Do.
1913	538	do	Do.

[1] Section.

OSAGE-ORANGE EXTRACTS.

General Information.

Not mentioned specifically.

Act of 1913, paragraph 30: "* * * all extracts of vegetable origin suitable for dyeing, coloring, or staining, not specially provided for in this section; all the foregoing not containing alcohol and not medicinal, ⅜ of 1 cent per pound."

Description.—Osage orange or bow wood is a North American tree, native to Arkansas, Oklahoma, and Texas. This tree is botanically known as the *Toxylon pomiferum* or *Maclura pomiferum*, of the family Urticaceæ. The tree grows to a height of 20 to 60 feet, depending on the character of the soil, and bears an inedible fruit. The leaves can be used as a substitute for mulberry in feeding the silkworm. The wood is of a bright yellow color, fine grained, and on account of its elasticity was used by the Indians for bows. It is now used for wagon felloes and in large quantities for fence posts. In the West it is extensively used for hedges.

The properties of osage-orange extract are nearly identical with those of the extract made from the imported fustic wood. It is marketed as a liquid extract of 51° Tw. and as a solid powdered extract. One extract is sold under the name of "aurantine." Like fustic, it contains morin, or moric acid, and maclurin or moritannic acid, and in addition a small amount of unknown reddish coloring matter which is present in smaller quantity than in fustic. This is a distinct advantage, as osage orange gives clearer shades. The fustic yellows are of a reddish shade, while the osage orange are of greenish shade.

Uses.—Osage orange is used in dyeing textiles, leather, and paper. The most extensive use of osage orange in dyeing is for old-gold shades with chromium mordants and for olive and brown shades with iron and copper salts, and also as a constituent of compound shades with other natural dyes. As a self-color it gives a bright yellow with tin salts and a greenish yellow with aluminum salts. These shades are not of sufficient fastness to be of extensive commercial value.

In dyeing chrome-tanned leather, it serves as a dye and also as a mordant for fixing basic dyes. It is used as a tannage and as a decolorizing agent for improving the color of chestnut and other vegetable tanning extracts.

Domestic production.—The commercial use of osage orange as a dye is of comparatively recent origin. The wood was used by the Indians of the Red Valley region of Texas for dyeing their blankets and fabrics. The shortage and high cost of the imported fustic wood during the war served as a stimulus for the extensive development of this dyewood.

The manufacture of osage-orange extract constitutes a small part of the dyewood-extract industry. Four plants report manufacture of this extract, together with other dye or tanning extracts. The raw material, osage-orange wood, is a domestic product, available in abundant quantity in Texas and Oklahoma. As the tree is usually misshapen and irregular, there is a large sawmill waste in its manufacture. Inquiries by the forest department indicate that the annual mill waste amounts to 40,000 tons per year in Texas and

Oklahoma. The wood is shipped from the interior to eastern extract plants by rail.

The equipment necessary and the method of manufacture is similar to that used in the manufacture of logwood extract. The wood is chipped, extracted by hot water under pressure, and the resulting solution evaporated under reduced pressure to form the "osage-orange extract" of 51° density, or to a solid which is marketed as a powder.

Plants manufacturing osage orange are located in New York and West Virginia. Further development of this dye warrant the establishment of a plant in the West, at the source of wood supply. This would result in a considerable economy of freight. A plant now erected at Durant, Okla., called the "Blue River Extract Co.," will start operation in September, 1920.

The domestic production of powdered and liquid osage-orange extract in terms of 51° Tw. was 1,458,213 pounds in 1916, the first year of its commercial production. This increased to 2,802,971 pounds in 1917, 3,259,164 pounds in 1918, and 4,827,701 pounds in 1919.

During the war osage orange was exported to Europe in small quantities. Data are not available on the quantities exported.

Foreign production.—Osage orange is a domestic tree; the extract is not made in other countries.

Prices.—The extract 51° Tw. was quoted in 1918 at 10½–12 cents per pound. In 1919 this receded to 8½–9 cents per pound. Osage orange, powdered, in 1919, was 25–26 cents per pound; for the last half of 1919 it was 18–19 cents per pound, advancing to 19–20 cents per pound in 1920.

Competitive conditions.—The imported fustic dyewood is at present the only foreign dyewood competitor of osage orange. As previously stated, the properties and uses are similar. The principal cost in osage orange in the past has been the freight on the wood. This will be reduced by the manufacture of extract in the West. Osage orange yields about 20 per cent less extract than fustic. Because of the greater cost of fustic wood, there is still a margin in favor of osage orange. Domestic quercitron preparations and coal-tar dyes are also competitive with osage orange.

Tariff history.—Osage orange would presumably be included in paragraph 30 of the act of 1913, "* * * all extracts of vegetable origin suitable for dyeing, coloring, or staining, not specially provided for in this section; all the foregoing not containing alcohol and not medicinal, ⅜ of 1 cent per pound."

Imported fustic wood, the competitor of osage orange is free of duty; the fustic extract is dutiable by the act of 1913 at three-eighths of 1 cent per pound.

Osage orange extract, 51°, liquid—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918[1]	1919	1920	Month.	1918[1]	1919	1920
	Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*
January	10½–12	12–12½	9–10	July	[2] 11–12	8½–9	.....
April	[2] 10½–12½	9– 9½	.....	October	12	8½–9	.....

[1] Not quoted prior to 1918.

[2] 42°, liquid.

Osage orange extract, powdered—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Months.	1919	1920	Month.	1919	1920
	Cents.	*Cents.*		*Cents.*	*Cents.*
January	25-26	19-20	July	19-19	.....
April	19-20	.....	October	18-19	.....

Osage orange extracts—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	81	Logwood and other dyewoods, extracts and decoctions of	10 per cent ad valorem.
1890	26	Extracts and decoctions of logwood and other dyewoods, * * * and extracts of barks, such as are commonly used for dyeing or tanning, not specially provided for in this act.	⅞ of 1 cent per pound.
1894	18	Extracts and decoctions of logwood and other dyewoods, extract of sumac, and extracts of barks, such as are commonly used in dyeing or tanning, not specially provided for in this act * * *.	10 per cent ad valorem.
1897	22	Extracts and decoctions of logwood and other dyewoods, and extracts of barks, such as are commonly used for dyeing or tanning, not specially provided for in this act.	⅞ of 1 cent per pound
		Extracts of * * * woods other than dyewoods, not specially provided for in this act.	⅝ of 1 cent per pound.
1909	22	Extracts and decoctions of logwoods and other dyewoods, and extracts of bark, such as are commonly used for dyeing or tanning, not specially provided for in this section.	⅞ of 1 cent per pound.
		* * * all extracts of vegetable origin suitable for dyeing, coloring, staining, or tanning, not containing alcohol and not medicinal, and not specially provided for in this section.	15 per cent ad valorem.
1913	30	Extracts and decoctions of * * * logwood, and other dyewoods, and all extracts of vegetable origin suitable for dyeing, coloring, or staining, not specially provided for in this section; all the foregoing not containing alcohol and not medicinal.	⅝ of 1 cent per pound.
		* * * all extracts of vegetable origin suitable for dyeing, coloring, or staining, n. s. p. f. in this section; all the foregoing not containing alcohol and not medicinal.	Do.
		Imported fustic wood, the foreign competitor of osage orange	Free.
		Fustic extract	⅝ of 1 cent per pound.

PERSIAN BERRIES.

Act of 1913, free.

Act of 1913, paragraph 30: "Extracts and decoctions of * * * Persian berries * * * ⅜ of 1 cent per pound."

General Information.

Description.—Persian berries are the dried half-ripe fruit of different buck-thorn (Rhamnus) species and are used for yellows and browns in the textile industry. The true berries are derived from the *Rhamnus amygdalinus, Rhamnus oleoides, Rhamnus saxatilis;* those from Aleppo and Smyrna are the most highly valued.

The berries are yellowish green, with a hard shriveled surface readily divisible into four parts along well-formed depressions; each part contains a triangular seed. They are about the size of a pea and possess an intensely bitter taste.

The French or Avignon are derived from the *Rhamnus infectorius* and the *Ramnus alaternus.* These are smaller and contain two seeds. The Spanish, Italian, and Hungarian berries are, respectivly, derived from the *Rhamnus saxatilis, Rhamnus infectoriun, Rhamnus cathartica.*

Persian berries contain glucosides which by decomposition with acids give the coloring matters, rhamnetin, rhamnazin, and quercetin.

The chief coloring matter rhamnetin forms yellow needles sparingly soluble in acetic acid and alcohol. In alkaline solutions it dissolves with a pale yellow color and gives with alcoholic lead acetate an orange red precipitate. It is a strong dyestuff and possesses dyeing properties similar to those of quercetin.

Rhamnazin present in small quantity forms yellow needles differing from rhamnetin and quercetin in its solubility in hot toluene. It is soluble in alkaline solutions to an orange yellow color and gives an olive green coloration with alcoholic ferric chloride. It dyes mordanted wool and acts as a weak color toward mordanted cotton.

The extract used in the textile industry is prepared by treating the berries with boiling water and evaporating the resulting liquid under reduced pressure.

Uses.—Persian berries are principally used in cotton printing for yellow, orange, and olive-green shades. The shades produced by Persian berries in dyeing and printing are similar, although slightly redder, to those given by the less costly domestic dyes, quercitron and osage orange. Clear yellow and orange shades are given with tin and aluminum salts of only fair fastness to light. With copper an olive green of exceptional fastness to light is produced. It has practically no application on wool at present. It is also used to some extent for staining paper, leather, and in the preparation of a yellow artists' pigment, known as schuttgelbs.

Imports.—The prewar imports in the period 1910 to 1914 varied from 64,883 pounds, valued at $7,173, in 1913, to 103,374 pounds, valued at $9,608, in 1911. The maximum import was in 1914, amounting to 114,336 pounds, valued at $12,924. This import decreased to 17,353 pounds in 1916; 8,507 pounds in 1917; until in 1918 no imports were made of this article.

Prices.—The prewar price on berries was 15 cents per pound. During the period 1915, 1916, 1917 only the extract was quoted. The price on extract, 1912–1915, was 12–14 cents per pound. In 1916 this increased to 20–25 cents per pound, reaching the maximum figure of 75–80 cents per pound in 1918. In January, 1920, this price receded to 45–50 cents per pound.

Tariff history.—Persian berry, extract, but not the berries themselves, have been specifically provided for. The berries are free either as berries not edible in a crude state or as articles in a crude state used in dyeing or tanning. The extract was dutiable before 1909 as an unenumerated article. Under the act of 1909 it was dutiable at 20 per centum ad valorem, and under the act of 1913 at three-eighths of 1 cent per pound.

Persian berries, extract—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quntity.	Actual and computed ad valorem rate.
		Pounds.				
1910	20 per cent	82,728	$7,860	$1,572	$0.095	20.00
1911	do	103,374	9,608	1,922	.093	20.00
1912	do	81,363	9,020	1,804	.111	20.00
1913	do	64,883	7,173	1,435	.111	20.00
1914	Compound	114,336	12,924	944	.113	7.30
1915	⅜ cent per pound	92,876	12,245	348	.131	2.84
1916	do	17,353	4,227	65	.243	1.54
1917	do	8,507	1,837	32	.215	1.74
1918						

Persian berries—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	15	15	15	.....	.....	.....	.....	(1)	(1)
April	15	15	15	.....	.....	.....	(1)	(1)	.....
July	15	15	15	.....	.....	.....	(1)	(1)	.....
October	15	15	.....	.....	.....	.....	(1)	(1)	.....

[1] Nominal.

Persian berry (extract)—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	12–14	12–14	12–14	12–14	12–14	20–25	75	(1)	45–50
April	12–14	12–14	12–14	12–14	20–25	20–25	75–80	(1)	.....
July	12–14	12–14	12–14	12–14	20–25	20–25	(1)	(1)	.....
October	12–14	12–14	12–14	12–14	20–25	20–25	(1)	(1)	.....

[1] Nominal.

Persian berries—Rates of duty.

Not specifically provided for.

Extracts of Persian berries—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1909....	22	* * *; extract of Persian berries.....	20 per cent ad valorem.
1913....	30	Extracts * * * of Persian berries.....	⅛ of 1 cent per pound.

COURT AND TREASURY DECISIONS.

Persian berry extract was held dutiable as an unenumerated manufactured article under section 6 of the act of 1897 rather than as a color under paragraph 58 or by similitude either to berries advanced under paragraph 20 or to the "extracts and decoctions of logwood and other dyewoods, and extracts of barks, such as are commonly used for dyeing or tanning," which were enumerated under paragraph 22. (United States *v.* Berlin Aniline Works, 154 Fed. 925 of 1907; Siegle *v.* United States, 166 Fed. 1015 of 1908.) A like classification was made under the act of 1883. (Sykes *v.* Magone, 38 Fed. 494.)

QUERCITRON AND FLAVINE.

SUMMARY.

Quercitron is the ground bark of the black oak. It is the most important domestic natural dye. The black oak (*quercus velutina*) occurs in Pennsylvania, Virginia, West Virginia, Maryland, and

the Carolinas. From the bark solid and liquid extracts and the dye flavine are manufactured. These are used for dyeing textiles and for the preparation of color lakes. The United States exports quercitron preparations to England, Germany, France, Switzerland, and Italy. The bark is of domestic origin, the quercitron preparations are of domestic manufacture, and the development of the industry has been independent of the tariff. The census of manufacture gives the 1914 production as 3,844,882 pounds, valued at $112,945.

GENERAL INFORMATION.

Not specifically mentioned, extract probably included.

Act of 1913, paragraph 1913: * * * and all extracts of vegetable origin, suitable for dyeing, three-eighths of 1 cent per pound.

Description.—Quercitron is the ground bark of certain species of oak. The *Quercus nigra* or *Quercus velutina* (black oak) furnishes the commercial supply and is of abundant occurrence in Pennsylvania, Virginia, West Virginia, Maryland, and the Carolinas. It is the most important domestic natural dye both in quantity and value of production. The coloring matter lies mostly between the outer and inner barks. The dyeing properties are similar to those of the more expensive imported fustic and Persian berries.

The bark contains quercitrin, a glucoside which on acid treatment gives quercetin. Both compounds are strong dyestuffs. Quercitrin, when pure, forms pale yellow crystalline needles of weakly acid character, slightly soluble in cold and freely soluble in hot water and alkaline solutions. An aqueous solution of quercitron gives bright yellow color lakes with tin and copper salts, brown-yellow with chromium salts, and deep olive with iron salts. When boiled with a dilute acid it forms the sugar rhamnose and quercetin. The latter compound is insoluble in cold water, sparingly soluble in hot water, and freely soluble in alkaline solutions. Quercetin gives red-brown shades with chromium salts, brown-orange shades with aluminum salts, and bright orange shades with tin salts. It occurs in small amounts in the flowers and roots of the chestnut, buckwheat, and other plants. The bark is sold by the ton as received; as "rossed" bark, in which the outer bark is mechanically removed, and as ground quercitron bark.

Quercitron is marketed as "bark extract" of 51° Tw., as solid quercitron. These extracts are made by water extraction of the ground bark.

Flavine is a dyestuff, manufactured from bark, possessing over 16 times greater tinctorial value than the ground bark. It is sold as a powder and gives more brilliant shades than quercitron bark or the extracts. There are 15 varieties of flavine. These include "yellow flavine" and "red flavine" and products especially adapted for color lakes, dyeing, or printing.

"Deflavinized extract," a by-product of flavine manufacture, is used in tanning pigskin and light leather, producing a leather of excellent strength. It is a nonplumping tannage and is used in conjunction with chestnut and quebracho extracts.

"Flavine lake" and "quercitron lake" are made by precipitating with chalk the dye solution containing alum. These lakes are used for wall-paper printing and interior decorations. They are charac-

terized by their retention of color tone and intensity in artificial light. Combined with basic coal-tar dyes they serve as a base for green color lakes.

Uses.—Quercitron preparations and flavine are used for yellows, oranges, and compound shades in the printing and dyeing of cotton, wool, silk, straw, and for color lakes used in wall-paper printing and interior decorations.

It is used in large quantities for khaki and olive shades on uniform, tent cloths, and linings. In 1916 three American textile firms alone used 1,112,000 pounds of extract for this purpose. In compound shades it is used with cutch and logwood extracts. Flavine is used for the production of brilliant yellow to red-orange shades. On wool these shades are fast to milling. In the dyeing and printing of quercitron preparations and flavine, tin, aluminum, chromium, and copper salts are used as mordants.

The textile trade is accepting quercitron extracts as a substitute for the more costly imported fustic. During the war wholesalers sold large amounts of quercitron extract as fustic extract. It is still added to fustic to reduce the cost of the latter. Flavine is used as a base for the manufacture of a "direct" yellow dye, both in the United States and in Europe. Recently quercitron preparations have been developed capable of dyeing by a "one-dip method," thereby eliminating the cost of separate operations ordinarily necessary for mordanting.

Raw materials.—Quercitron is a by-product of the lumber industry. The black oak after felling is "barked." The logs after peeling are cut up for heavy timber and crossties. As the bark can only be removed in the spring when the sap rises, the entire year's supply is peeled during that season and later is shipped to the extractor, who for this reason is obliged to keep a year's supply on hand. The bark is bought on the ton basis from the farmer or lumber dealer by the jobber, who in turn sells to the extractor. Black-oak bark is handled in large quantities in Pennsylvania, Virginia, Georgia, West Virginia, Maryland, and North Carolina. The present stand of black oak is estimated to be 23,000,000,000 feet board measure, or 15 per cent of the total oak.

Equipment.—The equipment required for the manufacture of quercitron extracts and flavine includes a shredder for disintegrating the bark, copper autoclaves, each of 1 to 2 tons capacity, capable of withstanding moderate pressures for extracting the shredded bark, cyprus storage and filter tanks, and a triple and single effect vacuum evaporators for concentration of the solutions. All of this equipment is obtainable in the United States.

Method of manufacture.—The bark as received from the storage shed is fed directly to the shredder, whereby the action of several dozen loosely fixed hammers swung from a horizontal shaft at a very high rate of speed disintegrates the bark into small pieces, and in part to a powder.

From the shredder the ground bark is mechanically conveyed to storage bins over the autoclaves and is fed by gravity into the autoclaves for extraction. These are of heavy copper, built to withstand pressures up to 100 pounds. As traces of iron seriously darken the finished product, brass piping is used in all connections.

The pressure, temperature, and time of extraction all influence the character of the product and are controlled in order to give the red or yellow product. In certain cases open extraction without pres-

sure is used. To accelerate the hydrolysis of the quercitron to quercetin, an acid treatment is frequently given. In addition, the extract may be subjected to an oxidation by blowing air through the hot dye extract solution. The details of extraction and manufacture are kept secret and vary considerably among the different manufacturers.

From the autoclaves it is pumped to a feed tank and thence passes through open filter tanks, where suspended solids or fibers are removed. The evaporation is carried out in triple effect evaporators. During this operation the liquors for certain products may be given an acid or oxidizing treatment. The concentrated extract is drawn from the triple effect evaporators to the barrel filling tanks, or for the production of solid extract the final evaporation is carried out in a single effect evaporator, and the thick liquid drawn into paper lined boxes where it solidifies on cooling. Special variations of the above treatments are used in preparing the highly concentrated flavine. "Deflavinized extract" used for tanning leather is a by-product from flavine manufacture. The quercitron extract plants are usually operated 24 hours a day, on account of the keen competition and the low margin of profit.

Organization.—Establishments producing quercitron preparations manufacture other dye or tanning extracts. There are at present five large quercitron manufacturers. The investment in equipment and plant is several thousand dollars per barrel per day output of extract.

Geographical distribution.—The plants manufacturing quercitron and its preparations are located near the supply of bark in the following States: Pennsylvania, Virginia, Tennessee, and New Jersey.

History of the industry.—In 1795 Dr. Bancroft discovered that when the bark of the black oak was ground and boiled with water it yielded a yellow dye of excellent quality. He received a patent from King George III granting him sole use of the ground bark, which he called quercitron. Consequently it may be called one of the first American dyes. In Baltimore shortly after 1860 quercitron and flavine were manufactured on a large scale; production has continued uninterruptedly since that date. The regulation scarlet coats formerly used in the British Army were dyed with flavine and cochineal. To-day it is the most important domestic natural dyestuff both in quantity and value produced.

Domestic production and consumption.—In 1914 four firms produced 3,844,882 pounds of quercitron extracts, valued at $112,945 (Census of Manufacturers). Production is not separately given for other years. In reply to a questionnaire sent out by the Tariff Commission, the reported domestic production of quercitron extracts in terms of 51° Tw. extract in 1916 was 14,637,123 pounds; in 1917, 15,983,720 pounds; in 1918, 10,655,985 pounds; in 1919, 7,653,168 pounds. These figures do not include flavine. The average yearly production of flavine for the period 1914–1919 was 94,380 pounds. The domestic production exceeds the consumption. The United States is an exporter of quercitron extracts.

Exports.—Previous to the war, Germany and Switzerland were the important consumers of quercitron extracts and flavine. In fact two large coal-tar dye manufacturers in Germany and Switzerland used American solid quercitron and flavine in the preparation of color lakes and a yellow dye. During the war, England imported

large quantities of quercitron preparations for dyeing army textiles, and Italy used smaller quantities during that period.

Information in possession of the Tariff Commission indicates that over 1,000,000 pounds of quercitron preparations were exported in 1917; this was the maximum export year for these products. This 1917 export was approximately 10 times the prewar export of 1913.

Foreign production and imports.—Quercitron bark is a product of domestic growth. The various quercitron preparations are products of domestic manufacture, consequently there are no imports. France has a high duty on the quercitron extract—30 francs per 100 kilos, corresponding to $5.79 for 220 pounds, or 2.63 cents per pound.

Prices.—Quercitron bark sold during the period 1912–1915 for $22–$30 per ton, increasing in the latter half of 1916 to $75–$80 per ton. This figure held during 1917. In the first part of 1918 it was quoted at $32–$35, receding to $12.10–$15 per ton in the latter part of the year. In 1919–20 the bark was quoted at $13–$15 per ton. Rossed bark was quoted in the latter part of 1918 at $18–$22 per ton, and during 1919 and 1920 at $19–$22 per ton. From the latter part of 1918 to 1920 ground bark was quoted at $26–$30 per ton.

Quercitron liquid 51° (bark extract) is quoted in 1916 (January) at 14–15 cents per pound; in January, 1917, 5–6 cents per pound; in the first half of 1918 at 6¾–7½ cents per pound, and the last half at 7–7½ cents per pound. During 1919 and 1920 it varied from 6–7½ cents per pound.

Solid quercitron is quoted at 2¾–4 cents per pound in the years 1912, 1913, 1914, and the first part of 1915. In the latter part of 1915 the price increased to 12–13 cents per pound, reaching the maximum of 30 cents in the first part of 1916. It gradually receded from this quotation to 11–12 cents in the latter part of 1916. In 1917 solid quercitron was quoted at 11–12 cents a pound. During 1918, 1919, 1920, the quotation varied from 11 to 14 cents per pound.

Flavine during 1912–13 and the first half of 1914 was quoted at 40–60 cents per pound. From last part of 1914 to the middle of 1916 it was quoted at 60–80 cents, increasing in the latter year to $1.25–$1.50 per pound. The quotation in 1917 was $1.25–$1.50 per pound; for 1918 and the first part of 1919, $1 to $1.10 per pound. In January, 1920, flavine was quoted at $0.90–$1 per pound.

Tariff considerations.—The imported fustic is competitive with quercitron. Fustic wood is not dutiable; the extract by the act of 1913 is dutiable at three-eighths of 1 cent per pound. The fustic extracts have sold for a higher price than the quercitron preparations. For certain uses the fustic extracts can not be displaced by the quercitron preparations. Domestic osage orange is also competitive with quercitron.

Quercitron extract—Production in United States—States and cities.

	1914[1]	
	Pounds.	*Value.*
4 establishments	3,844,882	$112,945

[1] Figures not available prior to 1914.

Quercitron bark—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920[1]
January...	$22–$25	$22–$25	$22–$25	$25–$30	$25–$30	$75–$80	$32–$35	[1] $13–$15	$13–$15
April.....	22– 25	22– 25	22– 25	25– 30	35– 45	75– 80	32– 35	[1] 13– 15	13– 15
July.....	22– 25	22– 25	22– 25	25– 30	75– 80	75– 80	[1] 12.10	[1] 13– 15	13– 15
October...	22– 25	22– 25	25– 30	25– 30	75– 80	75– 80	[1] 13– 15	[1] 13– 15	13– 15

[1] Rough bark, f. o. b. works.

Quercitron, rossed bark—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918	1919	1920
January.....	.....	$19–$22	$19–$22
April.....	.....	19– 22	19– 22
July[1].....	$18–$21	19– 22	19– 22
October.....	19– 22	19– 22	91– 22

[1] Not listed previously.

Quercitron, ground bark—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1918	1919	1920	Month.	1918	1919	1920
January.....	.....	$27–$30	$27–$30	July.....	[1] $26	$27–$30	$27–$30
April.....	.....	27– 30	27– 30	October.....	$27– 30	27– 30	27– 30

[1] Not given previously.

Quercitron extract, liquid, 51°—Prices, in cents per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January.....	.....	.....	.....	.....	14–15	5–6	6½–7½	7 –7½	6–7
April.....	.....	.....	.....	.....	.....	.....	6½–7½	6½–7	6–7½
July.....	.....	.....	.....	.....	.....	.....	7 –7½	6 –7	7–7½
October.....	.....	.....	.....	.....	.....	(1)	7 –7½	6 –7	7–7½

[1] Not given.

Quercitron extract, solid—Prices, in cents per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Month.	1912	1913	1914	1915	1916	1917	1918	1919	1920
January.....	[1] 2¾–4	[1] 2¾–4	[1] 2¾–4	2¾–4	30	11–12	12	13–14	11–13
April.....	[1] 2¾–4	[1] 2¾–4	[1] 2¾–4	2¾–3	25–35	11–12	12	13–14	11–13
July.....	[1] 2¾–4	[1] 2¾–4	[1] 2¾–4	5–6	15–20	11–12	13–14	11–13	12–13
October.....	[1] 2¾–4	[1] 2¾–4	[1] 2¾–4	12–13	11–12	11–12	13–14	11–13	12–13

[1] Not specified whether solid or liquid.

Flavine—Prices per pound, wholesale, New York.

[From Oil, Paint and Drug Reporter.]

Month.	1912	1913	1914	1915	1916
January	$0.40–$0.60	$0.40–$0.60	$0.40–$0.60	$0.60–$0.80	$0.60–$0.80
April	.40– .60	.40– .60	.40– .60	.60– .80	.60– .80
July	.40– .60	.40– .60	.40– .60	.60– .80	1.25– 1.50
October	.40– .60	.40– .60	.60– .80	.60– .80	1.25– 1.50

Month.	1917	1918	1919	1920
January	$1.25–$1.50	$1.00–$1.19	$1.00–$1.10	$0.90–$1.00
April	1.25– 1.50	1.00– 1.10	1.00– 1.10	.90– 1.00
July	1.25– 1.50	1.00– 1.10	1.00– 1.10	.....
October	1.25– 1.50	1.00– 1.10	.90– 1.00	.....

Quercitron and quercitron preparations—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	84	Logwood and other dyewoods, extracts and decoctions of	10 per centum ad valorem.
1883	509	Dyeing or tanning: Articles in a crude state used in dyeing or tanning, not specially enumerated or provided for in this act.	Free.
1883	689	Dyeing or tanning: Articles in a crude state, used in dyeing or tanning, not specially enumerated or provided for in this act.	Do.
1890	26	Extracts and decoctions of logwoods and other dyewoods, * * * extracts of barks, such as are commonly used for dyeing or tanning, not specially provided for in this act.	⅛ of 1 cent per pound.
1890	492	Articles in a crude state used in dyeing or tanning, not specially provided for in this act.	Free.
1894	386	....do	Do.
1894	16½	Drugs, such as barks, * * * and woods used expressly for dyeing; * * * not edible, but which are advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially provided for in this act.	10 per centum ad valorem.
1894	470	Drugs, such as barks, * * * and woods used expressly for dyeing * * * which have not been advanced in value or condition * * *	Free.
1897	482	Articles in a crude state used in dyeing or tanning, not specially provided for in this act.	Do.
1897	22	Extracts and decoctions of logwood and other dyewoods and extracts of barks, such as are commonly used for dyeing or tanning, not specially provided for in this act.	⅛ of 1 cent per pound.
1909	499	Articles in a crude state used in dyeing or tanning, not specially provided for in this section.	Free.
1909	20	Drugs, such as barks, * * * and woods used expressly for dyeing or tanning * * * not specially provided for * * * advanced in value or condition by any process or treatment whatever * * *.	¼ of 1 cent per pound.
		And in addition thereto	10 per centum ad valorem.
1909	559	* * * not advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the drugs and the prevention of decay or deterioration pending manufacture * * *.	Free.
1913	30	Extracts and decoctions of * * * logwood and other dyewoods, and all extracts of vegetable origin suitable for dyeing, coloring, or staining, not specially provided for * * *.	⅛ of 1 cent per pound.
1913	477	Drugs, such as barks, * * * logs, roots, stems * * * in a crude state, not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process or treatment whatever beyond * * *.	Free.
1913	624	Tanning material: * * * extracts of * * * hemlock bark * * * and other barks and woods other than dyewoods such as are commonly used for tanning not specially provided for in this section; * * * and woods used expressly for dyeing or tanning, whether or not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process; and articles in a crude state used in dyeing or tanning; * * *	Do.

COURT AND TREASURY DECISIONS.

Primuline buff, a preparation from quercitron or black oak bark and alizarin, was held dutiable under the act of 1890 as a dyewood extract and not as a coal-tar color. (United States *v.* Matheson, 54 Fed. 492 of 1893.)

RED WOODS.

SUMMARY.

The "redwoods" including the soluble, as brazilwood, etc., and the insoluble as cam, sanders, etc. have a limited application in dyeing usually with other dyewoods. They are the least important dyewoods and are imported from different tropical countries. The red woods are not grown in the United States.

The crude woods are shown on the free list as far back as 1883. The extracts are dutiable. In 1894 the rate was 10 per cent ad valorem. In 1897 this was changed to seven-eighths of a cent a pound. By the act of 1913 this rate was reduced to three-eighths of 1 cent per pound.

The extraction of the soluble redwoods (the insoluble redwoods are used directly by the dyer) constitutes a small part of the dyewood industry. With the increasing competition of the fast coal-tar dyes, the use of redwoods has no promise of expansion.

GENERAL INFORMATION

Crude woods.—Act of 1913, paragraph 624: Tanning material * * * and articles in a crude state used in dyeing or tanning, all the foregoing not containing alcohol and n. s. p. f. in this section, free.

Extracts.—Act of 1913, paragraph 30: Extracts and decoctions * * * and other dyewoods * * * suitable for dyeing, coloring, staining, n. s. p. f. in this section, all the foregoing not containing alcohol and not medicinal, three-eighths of 1 cent per pound.

DESCRIPTION.

The "red woods" are the least important of the natural dyewoods. They have limited use in dyeing and in the preparation of lake pigments and are divided into two classes—the soft, or "soluble red woods," and the hard, or "insoluble red woods."

The soluble red woods are obtained from the various species of the genus *Cæsalpinia*. The term "Brazil wood" is frequently used to designate certain varieties of this class. Of the nine varieties in use, the following are the most important: Brazil, Peach, Sapan, Pernambuco, and Lima wood. The term "hypernic" is applied to the Brazil wood extracts.

Pernambuco wood is obtained from the true *Cæsalpinia, ciesta* occurring abundantly in Jamaica and Brazil. It is yellowish red in the interior, becoming red to red brown on the surface. This variety is richest in coloring matter.

Brazil wood is obtained from the *Cæsalpinia brasiliensis*. The early Spaniards named the northern part of South America Brazil, from braza (fiery red), on account of the large quantities of red wood in the forests. It is brick red on the interior and brown red on the surface. The color content is about half that of Pernambuco wood.

Sapan wood is derived from the Asiatic tree *Cæsalpinia sapan*, found in Siam, China, Japan, and East Indies. The interior is yellowish red and the surface of a bright red color.

Lima wood is a variety of sapan wood imported from South and Central Americas; the Philippine variety is an inferior quality.

Peach and Santa Martha wood, considered by some as identical, are derived from the *Cæsalpinia echinata*, found in Mexico and Central America. It is a dull red in the interior and paler on the surface. There are other varieties of minor importance.

The coloring principle of brazilwood is brazilin. This is apparently present in all the soluble redwoods. By ageing or oxidation this is converted into the coloring matter, brazilein. This is held by some to have the same relation to brazilein that haemetin has to haemotoxylin.

Brazilin forms nearly colorless crystals, freely soluble in water, alcohol, and ether. It is easily oxidized by exposure to air to brazilein. This transformation is facilitated by the presence of alkali.

Brazilein forms minute dark needles of gray metallic luster, freely soluble in hot and slightly soluble in cold water and possesses strong dyeing properties, with aluminum salts it forms a red color lake.

The preparation of Brazil extract is carried out by a method similar to that used in the preparation of logwood extract. The chips are extracted with boiling water under pressure and the resulting thin solution evaporated under reduced pressure to form the commercial extract. Brazilwood extracts, commonly known as hypernic are sold as a 51° Tw. extract and as a solid. With aluminum salts it gives crimson and with chromium, purple shades.

By blowing air through an alkaline solution of brazilin treated with alum a red color lake is precipitated.

USES.

The largest use of hypernic is for leather dyeing. As a self color on textiles its use is limited on account of the poor fastness of its shades. In the textile trade it has application as a reddening constituent to modify the shades of fustic, logwood, and other natural dyes. In cotton printing it was formerly used for crimsons and reds with tin and aluminum mordant; to-day it is used only as a shading agent. It is of more importance for dyeing dark red and red chocolate leather. Brazilwood extracts are also used in the preparation of color lakes.

Insoluble redwoods.—The "insoluble redwoods" are more resinous and compact and are frequently known as "close woods" in contrast to the "open" soluble redwoods. This class includes sanders, cam, bar, calistur, and narra wood. On account of the insolubility of the coloring matter, extracts are not made, the rasped wood being used directly in the dyeing operations.

Sandalwood, the product of the *Pterocarpus santalinus*, found in the East Indies, India, Ceylon, and Africa, is a very hard dense wood, dark brown on the outside and blood red on the interior with an aromatic orris root like odor. It gives to alcohol about 16 per cent coloring matter insoluble in cold and slightly soluble in hot water. Only a small part of the coloring matter is utilized in the dyeing operations.

Barwood is derived from a large tree botanically known as the *Bophia nitida*, growing on the West Coast of Africa, Sierra Leone, Angola, etc. The physical characteristics are similar to those of sandalwood; it is of a brighter red color, without aromatic odor, the important difference being the higher percentage of coloring matter soluble in water. Boiling water extracts 7 per cent and alcohol about 23 per cent coloring matter.

Camwood is more expensive and gives fuller and brighter shades. It is probably derived from a variety of the *Bophia nitida*, growing on the West Coast of Africa. Caliatour wood, found in the East Indies, is considered a variety of camwood and is chiefly used on the Continent.

The coloring matter present in sanders wood, santalin is probably identical with the coloring matter of the other insoluble redwoods, it forms red crystals, practically insoluble in water, but soluble in ether and alcohol and alkalis. The insoluble redwoods in dyeing give red shades (aluminum and tin mordants), violet and brown shades with chronium and iron mordants.

In the past the insoluble redwoods have been used for the direct dyeing of wool and cotton, followed by a secondary treatment with a mordant for developing the color.

The insoluble redwoods are not used as a self-color but in conjunction with other dyewoods for various shades of brown and for imparting a purplish shade of blue to indigo on wool. The compound shades of the dyewoods, sanders, fustic, and logwood, are faster to light than the individual members alone. The coal-tar alizarins and anthracene dyes have largely displaced the redwoods on account of their greater fastness. This class is of very small importance in the textile industry.

Imports.—Imports for the different redwoods are not separately given, with the exception of camwood. The imports of the wood varied from one-half to 1½ tons per year in the period 1908–1915. In 1917, 80 tons were imported with a value of $5,991, or $75 per ton. In 1917 and 1918 no camwood was imported.

Prices.—(Brazil wood, hypernic.) The prewar price of Brazil wood (chipped) was 2–3 cents per pound, this increased to a maximum of 7–8 cents per pound in 1916. The crude wood is not quoted previous to 1918; in the first quarter of 1918 it was $40–$60 per ton, increasing to $75–$80 in the same year. The liquid hypernic 51° was 12–14 cents per pound in the first quarter in 1917. This increased to 33 cents per pound in 1918, returning to 12–13 cents per pound in 1920. Solid hypernic not quoted prior to 1917; it was 25–28 cents in the first quarter of that year. In 1919 the price increased to 45–46 cents per pound, decreasing to 15–18 cents per pound in the last quarter of 1918.

Camwood chips.—The prewar price on camwood chips was 6–7 cents per pound. This increased to 18–20 cents per pound in the second quarter of 1916 with no further change until January, 1920, when the price receded to 14–16 cents per pound.

Barwood chips.—The prewar price on barwood chips was 2–2½ cents per pound; this increased to 7–8 cents per pound in the last quarter of 1915 and then decreased to 6–8 cents per pound in the third quarter of 1916. This figure remained unchanged up to February, 1920.

Red sanders chips.—The prewar price on sanders chips was 3–5 cents per pound, this increased to 12–14 cents per pound in the second quarter of 1916, with no further change until 1919, when the price increased to 15–16 cents per pound.

TARIFF HISTORY.

The crude dyewoods are shown on the free list as far back as 1883. The redwoods are included with other dyewoods but not specifically mentioned.

The redwood extracts are dutiable. In 1894 the rate was 10 per cent ad valorem. In 1897 this was changed to seven-eighths of a cent per pound. By the act of 1913 this rate was reduced to three-eighths of 1 cent per pound. The redwood extracts are not specifically mentioned but are included in Extracts and decoctions of * * * and other dyewoods, at three-eighths cent per pound.

Camwood—Imports for consumption—Revenue.

Fiscal year—	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Tons.				
1908	Free	1	$76		$76.00	
1909	do	1	96			
1911	do	1	62			
1912	do	1	525		350.00	
1913	do	1	191			
1915	do	1	209		209.00	
1916	do	80	5,991		74.88	
1917	do					
1918	do					
1919	do					
1920	do					

Brazil wood—Prices, wholesale, per ton, New York.

[From Oil, Paint, and Drug Reporter.]

	1918 [1]	1919	1920
January	$40–60	$55–70	$50–60
April	75–80	50–65	Nominal.
July		50–60	Nominal.
October	52–70	30–50	Nominal.

[1] Not quoted prior to 1918.

Hypernic—Prices, per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	2–3	2–3	2–3	2–3	6–8	7–8	7–8
April	2–3	2–3	2–3	2–3	6–8	7–8	7–8
July	2–3	2–3	2–3	3–4	7–8	7–8	
October	2–3	2–3	2–3	6–8	7–8	7–8	

Hypernic extract, liquid 51°.—Prices, per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1917 [1]	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*
January	12-14	15-16	30-33	12-13
April	.....	.....	30-33	14-16
July	.....	33	30-33	16-17
October	.....	30-33	11-13	20-22

[1] Not quoted prior to 1917.

Hypernic extract, solid—Prices, per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1917 [1]	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*
January	25-28	31½	45-45½	16-18
April	.....	31½	45-46	18-20
July	.....	45	45-46	20-22
October	.....	45	15-18	28-30

[1] Not quoted prior to 1917.

Camwood chips—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	6-7	6-7	6-7	6- 7	16-20	18-20	18-20	18-20	14-16
April	6-7	6-7	6-7	6- 7	16-20	18-20	18-20	18-20	14-16
July	6-7	6-7	6-7	8- 9	18-20	18-20	18-20	18-20	14-16
October	6-7	6-7	6-7	16-20	18-20	18-20	18-20	18-20	16-20

Barwood chips—Prices, wholesale, per pound, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	2-2½	2-2½	2-2½	2-2½	7-8	6-8	6-8	6-8	6-8
April	2-2½	2-2½	2-2½	2-2½	7-8	6-8	6-8	6-8	6-8
July	2-2½	2-2½	2-2½	3-4	6-8	6-8	6-8	6-8	6-8
October	2-2½	2-2½	2-2½	7-8	6-8	6-8	6-8	6-8	6-8

Red sanders chips—Prices, per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	3-5	3-5	3-5	3- 5	8-10	12-14	12-14	12-14	15-16
April	3-5	3-5	3-5	3- 5	12-14	12-14	12-14	15-16	15-16
July	3-5	3-5	3-5	4- 5	12-14	12-14	12-14	15-16	13-16
October	3-5	3-5	3-5	8-10	12-14	12-14	12-14	15-16	15-16

Red woods—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
		CRUDE WOODS.	
1913	624	Tanning material * * * and articles in a crude state used in dyeing or tanning; all the foregoing not containing alcohol and n. s. p. f. in this section.	Free.
1909	499	Articles in a crude state used in dyeing or tanning n. s. p. f. in this section.	Do.
1897	482	Articles in a crude state used in dyeing or tanning n. s. p. f. in this act.	Do.
1894	386	.....do.....	Do.
1890	492	.....do.....	Do.
		EXTRACTS.	
1913	30	Extracts and decoctions * * * and other dyewoods * * * suitable for dyeing, coloring, staining, n. s. p. f. in this section, all the foregoing not containing alcohol and not medicinal.	⅛ of 1 cent per pound.
1909	22	Extracts and decoctions of logwood and other dyewoods * * * such as are commonly used for dyeing or tanning n. s. p. f. in this section.	⅛ of 1 cent per pound.
1897	22	Extracts and decoctions of logwood and other dyewoods * * * such as are commonly used for dyeing or tanning n. s. p. f. in this act.	Do.
1894	18	Extracts and decoctions of logwood and other dyewoods * * * such as are commonly used for dyeing or tanning * * *.	10 per cent ad valorem.

SAFFLOWER.

Act of 1913, paragraph 31: * * *; saffron and safflower, and extract of, and saffron cake, 10 per cent ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph."

GENERAL INFORMATION.

DESCRIPTION.

Safflower (known also as American saffron, African saffron, thistle saffron, false saffron, bastard saffron) a brilliant red natural dye, occurs in the dried flowers of a thistle-like plant Carthamus tinctorius. Although indigenous to southern Asia, it has been cultivated in China, India, Persia, Europe, Central and South America. It is not raised in the United States.

The flowers are gathered when in full bloom, and dried in the shade. In many places they are steeped in salt water to remove the worthless yellow coloring matter, after which they are kneaded, pressed, and dried. Good safflower has a fiery red color, a strong aroma, is cohesive, soft and delicate in fiber.

The value of safflower depends on a red insoluble coloring matter present to the extent of about 5 per cent, known as carthamin. There is also present about 30 per cent of a yellow soluble coloring matter, easily removed by water.

Carthamin is a weakly acid body insoluble in water and ether, but readily soluble in alkaline solutions. It is prepared by dissolving out the yellow coloring matter by washing the dried flowers with cold water. The red coloring matter carthamin is then dissolved from the flowers by dilute sodium carbonate solution.

On acidification of this solution carthamin is precipitated. As this is in an extremely fine condition and difficult to filter, it is customary to collect the color on cotton by dyeing the latter in an alkaline

solution of the dye gradually acidified. The color is dissolved from the cotton by an alkaline solution and precipitated with an acid in form of a brilliant red precipitate, this when mixed with water forms the "safflower extract or paste" of commerce.

USES.

Safflower is used as a coloring agent for cosmetics (rouge is made by mixing the dry color with starch, talc, etc.), liquors, confectionery, toilet articles, painters' colors, artificial flowers, and as a medicine. It was used formerly in dyeing bright pinks and fiery reds on cotton, linen, and silk. As the color is very fugitive, expensive, and of low-tinctorial value, it has been displaced by the coal-tar dyes, the "eosins," "rhodamines," and "safranines."

IMPORTS.

The imports of safflower are not separately listed. The total value of imports of saffron, safflower and extract of, in the period 1908 to 1914, varied from $67,648 in 1909 to $93,146 in 1913. The maximum import was in 1917 a total of $124,235; in 1918 the import was $53,961.

PRICES.

Safflower (saffron, American) was quoted in January, 1912, at 33 to 35 cents per pound. After several fluctuations it abruptly rose to 75 cents in the middle of 1915. In 1916 it reached its maximum of $1.75 to $1.85 per pound, gradually receding to 33 to 35 cents per pound in the latter part of 1919. In 1920 (January) it was quoted at 35 to 36 cents per pound.

TARIFF HISTORY.

By the act of 1913, paragraph 31, * * * saffron and safflower and extract and saffron cake are dutiable at the rate of 10 per cent ad valorem.

Previous to the 1913 act "saffron and safflower, and extract of, and saffron cake" were on the free list as far back as 1883.

Saffron, safflower, and extract of, and "saffron cake" not containing alcohol—Imports for consumption—Revenue.

[Paragraph 31.]

Fiscal year—	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free		$67,648			
1910	do		80,759			
1911	do		88,214			
1912	do		91,202			
1913	do		93,146			
1914	do		25,620			
1914	10 per cent		60,014	$6,001		10.00
1915	do		70,132	7,013		10.00
1916	do		111,420	11,142		10.00
1917	do		124,235	12,423		10.00
1918	do		53,961	5,396		10.00
1918 [1]	10 to 20 per cent		148	12		8.00
1919	10 per cent	16,459	77,273	7,727	$4.694	10.00

[1] 10 to 20 per cent, treaty with Cuba.

Saffron, American (safflower)—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	33–35	33–35	50 –55	35–38	$1.25	75–80	48–52	40–42	35–36
April	38–40	45–50	56 –75	32–35	1.35–1.40	65–70	45–50	35–38	33–34
July	36–38	30–32	50 –55	75–	1.75–1.85	45–50	45–47	33–35	Nominal.
October	35–36	55–60	42½–45	60–65	1.40–1.45	50–52	39–40	33–35	75–85

SAFFRON OR SAFFRON VALENCIA.

General Information.

Act of 1913, paragraph 31: * * *; saffron and safflower, and extract of, and saffron cake, 10 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

Description.—Saffron, known also as Valencia saffron, Spanish saffron, French saffron, consists of the dried petals (stigmata) of the *Crocus Sativus*. (*C. Officinalis* Martyn. Fam. Iridaceae). The plant has been successfully grown in the United States; the high cost of labor, however, renders its growth unprofitable. Although a native of southwestern Asia, it is cultivated in Spain, south of France, and Austria.

The *Crocus satirus* is a low bulbiferous plant with grass-like leaves. It yields a pale-purple flower. After gathering, the petals are subjected to a toasting process to develop the red color. The petals of about 4,000 flowers are required to make 1 ounce of dry saffron. The yield per acre is approximately 33 to 36 pounds.

Saffron contains 7 to 10 per cent of an aromatic oil of the terpene class, possessing the intense odor of saffron. It is known as saffron oil. In addition, saffron contains a bitter principle known as picrocrocin, or saffron bitter, of a glucosidal nature, and a yellow glucoside which on decomposition gives the sugar crocose and crocetin. The last-named compound is a red powder slightly soluble in water, but readily soluble in alcohol and in dilute alkalis with an orange-red color. According to Rochlider, the Chinese dyestuff "Wongsky," which consists of the fruit of the gardenia grandiflora, also contains crocin. Saffron is sometimes pressed into cakes known as saffron cake; the loose saffron is known as hay saffron.

Saffron is frequently adulterated with sugar, chalk, gypsum, barium sulphate. The coroll tubes of the crocus dyed with Brazil wood, calendula florits (marigold), such flowers as the red poppy, safflower, and other vegetable products dyed with coal tar or natural dyes, are also added. The faster and cheaper coal-tar dyes have displaced saffron as a dyestuff.

Uses.—Saffron is used as a food color, for flavoring purposes, and to a very limited extent as a dyestuff and as a medicinal. Fabrics mordanted with tin and aluminum are dyed orange and yellow shades, respectively.

Imports.—The imports of saffron are not separately listed. The total value of the imports of "saffron, safflower, and extract of, and

saffron" in the period 1908–1914 varied from $67,648 in 1909 to $93,146 in 1913.

The largest imports were made during the years 1916–1917. In the latter year the import value of "saffron, safflower, and extract of, and saffron" was $124,235; this is the maximum import. In 1918 the value of imports was $53,961.

Prices.—Saffron, Valencia, in the period 1912 to 1918 varied from $10.50 to $12.50 per pound, with the exception of the latter part of 1914 when it was quoted at $15 per pound. In 1918–19 it varied from $11.50 to $16 per pound. In 1920 it was quoted at $15 to $15.25 per pound.

Tariff history.—By the act of 1913, paragraph 31, * * * *saffron and safflower and extract and saffron cake* was dutiable at the rate of 10 per centum ad valorem.

Previous to the 1913 act "saffron and safflower, and extract of, and saffron cake" were on the free list as far back as 1883.

Saffron, Valencia—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915[1]	1916
January	$10.50–$10.75	$12.75–$13.00	$10.80–$11.50	$11.75–$12.00	$11.15–$11.50
April	10.00– 10.25	12.75– 13.00	12.00– 12.25	12.00– 12.25	11.00– 11.25
July	10.30– 10.50	12.00– 12.75	11.50– 11.75	11.75– 12.00	10.75– 10.80
October	11.25– 11.50	12.00– 12.50	14.00– 15.00	11.25– 11.50	11.00– 11.25

	1917	1918	1919	1920
January	$11.40–$11.50	$11.50–$12.00	$15.00–$16.00	$15.00–$15.25
April	12.00– 12.50	13.00– 13.50	13.75– 14.00	16.00– 16.50
July	12.00– 12.50	15.50– 16.00	13.25– 13.50	14.50– 14.75
October	11.50– 12.00	15.50– 15.75	14.00– 15.00	13.25– 13.50

[1] Listed "Spanish."

Safflower—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	586	Saffron and safflower, and extract of, and saffron cake	Free.
1890	694	do	Do.
1894	605	do	Do.
1897	651	do	Do.
1909	663	do	Do.
1913	31	* * * saffron and safflower, and extract of, and saffron cake *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.	10 per cent ad valorem.

Court and Treasury Decisions.

Saffron put up in packages of less than 2½ pounds classified at 20 per cent, paragraph 17, was held properly dutiable as saffron. (Abstract 41261, of 1917.)

TURMERIC.

[Act of 1913, paragraph 634—Free.]

GENERAL INFORMATION.

Description and production.—Turmeric is prepared from the tuber or underground stem of the various species of the curcuma; *Curcuma tinctoria, Curcuma longa, C. rotunda, C. viridiflora,* etc. These plants, indigenous to Southern Asia, are now cultivated.[1] The important varieties are the Chinese, Bengal, Madras, Aleppo, Pabna; exports are also made from Batavia, Cochin Malabar, and the Barbados. In India it is cultivated with ginger or yams; propagation is carried out by root cutting. A rich, well fertilized soil is required, with hand weeding in cultivation and frequent irrigation. Crop tests have yielded 13,000 to 16,000 pounds of fresh turmeric per acre, together with 6,000 to 9,000 pounds of yams. In cleaning there is a weight loss of about 20 per cent. The cost per acre of the above yield was between $60 and $75. In Madras about 3,000 to 5,000 pounds of prepared turmeric per acre are reported. While in other Provinces in India, only 2,000 pounds per acre of fresh roots are given. Reports of yields show wide variation.

In the preparation for market, the root is cleaned, boiled, and sun-dried. After these treatments the outer skin can be removed by rotating in a barrel by power. Until recently this last operation was carried out by rubbing with the feet.

The roots are externally greenish yellow and internally of a deep yellow to orange color. They vary in shape according to their source. Good commercial grades are hard, possessing a dull resinous fracture.

Turmeric root contains a yellow dye known as curcumin and in addition cellulose, gum, starch, mineral matter, a volatile oil, and a brown coloring matter. Pure curcumin, the coloring matter, forms yellow crystals readily soluble in alcohol and ether, and slightly soluble in water. In alkalis it dissolves with a reddish brown shade. With boric acid it gives a characteristic color reaction due, according to Schlumberger, to the formation of resocyanin.

Ground turmeric has a bright yellow color, a bitter taste, and a characteristic odor.

Uses.—Turmeric is used as a coloring matter and a condiment It finds application as a yellow dye in coloring medical preparations. oils, and waxes. As a condiment it is used in the preparation of curry powders. Probably the bulk of the American imports is utilized in the manufacture of "prepared mustard." In chemistry it is used as an indicator, serving as a valuable qualitative test for boric acid.

It was formerly used as a yellow dye and still finds some application in India for dyeing cotton and silk. As the shades are of extremely poor fastness, it has been displaced by the faster coal-tar dyes and is to-day of no importance in the textile industry.

Imports.—The United States imports come chiefly from India and China. The prewar yearly values of imports from 1908 to 1914 are fairly constant, averaging $33,105 per year. The increase in import values of 1916 and 1917 is in part explained by the war increase in price.

[1] They are not produced in the United States.

Prices.—Aleppo turmeric sold for 5⅜–6 cents per pound in 1912, gradually decreasing to 4¼–4½ cents per pound in 1914. From this minimum figure it increased, reaching its maximum in 1918 of 13–13½ cents per pound. In 1919, October, it sold for 9–11 cents per pound.

Madras turmeric sold in 1912–13 for 5¾–6¼ cents per pound, receding to the minimum price 4–4¼ cents in October, 1914. From this figure it increased irregularly to the maximum of 16½–17 cents in April, 1919, receding to 10½–11 cents in January, 1920.

Pabna turmeric sold for 5½–5¾ cents per pound in 1912–13. In October, 1914, it sold for 4 cents, gradually increasing to 11–11½ cents in April, 1920.

China turmeric sold for 3½ cents per pound in 1912–13, receding in 1915 to its minimum selling price of 3–3½ cents. From this point it increased with irregularities to the maximum 10½–11 cents in 1919. In January, 1920, it was quoted at 7¾–8 cents per pound.

Tariff history.—Turmeric is specifically shown on the free list as far back as 1894.

Turmeric—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				
1908	Free		$31,531			
1909	do		31,336			
1910	do		28,077			
1911	do		41,609			
1912	do		32,342			
1913	do		33,735			
1914	do		22,978			
1915	do		10,145			
1916	do		180,948			
1917	do		112,372			
1918	do		602			
1919	do	[1] 689,962	46,205		$0.0669	

[1] Quantity not previously shown.

Turmeric, Aleppy—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	5⅜–6	5⅜–6	4¼–4½	4¼–4½	4⅜–4½	[1]	10¾–11¾	13 –13½	9 – 9½
April	5⅜–6	5⅜–6	4¼–4½	4¼–4½	.....	9½–10	10¾–11¾	[1]	11 –12
July	5⅜–6	4⅞–5¼	4¼–4½	4⅜–4½	.....	10 –10½	[1]	9½–11	10 –10½
October	5⅜–6	4⅞–5¼	4¼–4½	4⅜–4½	.....	10 –10½	13 –13½	9 –11	9½– 9¾

[1] Nominal.

Turmeric, Madras—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	5¾–6¼	5¾–6¼	4¼–4⅜	4 –4¼	4⅜–4⅝	8¾–9	8½ –9½	12½–13	10½–11
April	5¾–6¼	5¾–6¼	4¼–4⅜	4 –4¼	.....	8¾–9	8½ –8¾	16½–17	11 –12
July	5¾–6¼	5¾–6¼	4¼–4⅜	4⅜–4⅝	.....	8¾–9	12 –12½	11 –13	9¾–10
October	5¾–6¼	5¾–6¼	4 –4¼	4⅜–4⅝	8¾–9	8¾–9	10¼–10½	11½–12	9 – 9½

Turmeric, Pubna—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	5¼–5½	5½–5¾	5½–5¾	4	5–5½	(1)	8½–9	9½–10	11 –11½
April	5½–5¾	5½–5¾	5½–5¾	4	.....	.....	8½–9	11 –11½	11 –11½
July	5½–5¾	5½–5¾	5½–5¾	5–5½	.....	.....	10½–11	11 –11½	10¾–11¾
October	5¾–5¾	5¾–5¾	4	5–5½	.....	.....	(1)	11 –11½	.....

[1] Nominal.

Turmeric, China—Prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	3¾	3¾	3¼–4¼	3 –3½	3⅝–3¾	8½–8¾	7½– 8	9 – 9¼	7¾–8
April	3¾	3¾	3½–4¾	3 –3½	.....	8¾–9	7½– 8	10½–11	7¾–8
July	3¾	3¾	3½–4¾	3⅝–3¾	.....	8¾–9	10½–10½	10 –10½	.....
October	3¾	3¾	3½	3⅝–3¾	8½–8¾	8 –8½	8¾– 9	9 –10	.....

Turmeric—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	634	Turmeric	Free.
1909	698	.....do	Do.
1897	686	.....do	Do.
1894	658	.....do	Do.

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UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 32, 33, 34, 35, 36, 37, and 38 OF THE TARIFF ACT OF 1913

Paragraph 32:
Formaldehyde [see Par. 2]

Paragraph 33:
Butyl alcohol (T. D. 37577)
Fusel oil or amylic alcohol

Paragraph 34:
Agar-agar
Gelatin
Glue
Isinglass

Paragraph 35:
Glycerin

Paragraph 36:
Amber and amberoid
Arabic or senegal
Camphor
Chicle
Dextrine and soluble starch

Paragraph 37:
Ink and ink powders

Paragraph 38:
Iodoform
Potassium iodide

Paragraph 515:
Iodine

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UNITED STATES TARIFF COMMISSION.

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PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of dis cussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and Index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Dr. Grinnell Jones, C. R. DeLong, Sidney D. Kirkpatrick, and A. R. Willis, of the chemical division of the Commission's staff, and of others.

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FORMALDEHYDE.

[Par. 32, act of 1913, 1 cent per pound. See par. 2.]

FUSEL OIL OR AMYLIC ALCOHOL.

[Par. 33, act of 1913, ¼ cent per pound.]

Summary table.

Fiscal year.	Domestic production.[1]	Imports for consumption.	Value (imports for consumption).	Amount of duty.	Value per pound.	Equivalent ad valorem rate.
	Pounds.[2]	*Pounds.*				*Per cent.*
1910	.....	4,970,538	$599,909	$12,426	$0.121	2.07
1911	.....	5,176,344	839,460	12,940	.162	1.54
1912	.....	5,468,554	1,464,031	13,671	.268	.93
1913	361,900	5,116,660	1,183,872	12,791	.231	1.08
1914	367,500	5,679,750	888,844	14,199	.156	1.60
1915	510,300	3,298,228	699,512	8,245	.212	1.18
1916	1,007,300	2,162,617	695,196	5,406	.321	.78
1917	1,094,800	1,612,297	629,099	4,031	.390	.64
1918	830,000	1,606,528	546,589	4,016	.340	.73
1919	480,389	1,464,500	386,416	3,881	.264	1.04

[1] Production is for calendar years except for 1918 and 1919, which are fiscal years, taken from annual reports of Commissioner of Internal Revenue.
[2] Gallons converted on basis of 7 pounds per gallon.

General Information.

Paragraph 33, "Fusel oil, or amylic alcohol, ¼ cent per pound."

Description.—Fusel oil is known under the following names: Fermentation amyl alcohol, potato oil, grain oil, marc brandy oil, fuselol (German), and huile de pomme de terre (French).

Commercial fusel oil consists of two isomeric forms of amyl alcohol. The one is optically inactive while the other form rotates the plane of polarized light to the left. The latter form is usually present in fusel oil in sufficient quantities to render it laevorotatory when tested with the polariscope. Fusel oil contains varying amounts of other homologous alcohols, traces of acids, and considerable water. The value of fusel oil depends chiefly on its content of amyl alcohol. The composition of fusel oil depends on the materials fermented, the nature and length of the fermentation, and the method of distillation.

There are two grades of fusel oil which are of commercial importance, a crude grade and a refined or rectified grade. The crude product is a light amber to straw-yellow colored liquid, usually clear, and having a persistent disagreeable odor. This crude grade is refined by distillation in an ordinary copper still. The refined grade is colorless, or nearly so, and practically free from water.

Uses.—The chief use of fusel oil is in the manufacture of amyl acetate, which is largely used as a solvent in the nitrocellulose industry.

(See Survey on "Ethers and esters.") One of the largest firms of amyl acetate manufacturers estimates that of the crude fusel oil imported not over 15 per cent is rectified, the balance (85 per cent) being converted into amyl acetate.[1] Other important uses of fusel oil are as a solvent for resins in spirit varnishes, pyroxylin lacquers, and as a cellulose nitrate solvent in conjunction with camphor. Fusel oil is used in minor quantities in the extraction of alkaloids and in the preparation of fruit ethers.

Domestic production.—The annual report of the Commissioner of Internal Revenue for the year ending June 30, 1918, shows that 119,590 gallons (about 7 pounds to the gallon) of fusel oil was removed from distilleries. Louisiana and Maryland produced two-thirds of the total. This is the only available figure on the domestic production of fusel oil.

Fusel oil is obtained as a by-product of fermentation processes. The chief sources are the production of distilled liquors (whisky, brandy, and rum) and of alcohol or cologne spirits. Apart from the desirability of removing the excess of fusel oil from spirits intended as beverages, the oil is removed for the salable value which it possesses. It is obtained, chiefly, in the alcoholic distillate coming over between 105° and 137° C.

The production of fusel oil in this country supplies only a small portion of the domestic consumption. The production in 1918 of about 830,000 pounds was about one-half of the quantity imported in that year, which was only about one-third of the normal prewar imports. The industries using fusel oil must rely to a large extent on foreign countries.

Imports.—The imports of fusel oil from 1910 to 1914, inclusive, averaged about 5,300,000 pounds per year. During these years 75 per cent of the total originated in Russia, United Kingdom, and Germany, with the quantity nearly equal from each country. Since 1914 the import has declined to a minimum in 1917 and 1918 of about 1,600,000 pounds. The decline is accounted for by the cessation of imports from Russia and Germany. In 1919 Canada, which had supplied only a small quantity in the past, furnished over 50 per cent of the total.

Tariff history.—Fusel oil was dutiable at 10 per cent ad valorem during the period covered by the acts of 1883, 1890, and 1894. The act of 1897 levied a duty of one-fourth cent per pound on fusel oil. This duty has been specified in the succeeding acts. The change in duty from 10 per cent ad valorem to a specific duty of one-fourth cent per pound amounted to a reduction of 8 per cent ad valorem, as the equivalent ad valorem since 1910 has been equal to less than 2 per cent. The revenue derived from the duty on fusel oil has varied from about $4,000 to $14,000 per annum since 1910.

There are no special tariff problems connected with fusel oil.

[1] Worden, E. C.: The Nitrocellulose Industry, 1911.

Fusel oil or amylic alcohol—imports by countries.

[Fiscal years.]

Imported from—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	168,858	$18,590	63,284	$10,056	43,397	$13,319
Belgium	274,871	32,784	587,019	105,669	229,389	66,691
France	287,468	31,959	225,295	36,073	655,429	164,807
Germany	926,760	108,387	1,342,282	224,701	1,241,544	346,594
Italy	107,764	11,965	162,123	27,359	71,783	19,590
Netherlands	11,122	1,241	11,667	1,925	46,820	15,255
Russia in Europe	1,686,573	208,281	1,573,902	255,245	1,381,794	384,507
United Kingdom	1,194,290	145,756	935,492	137,165	1,495,353	376,727
Canada	42,562	4,253	22,871	3,919	19,940	5,499
All other	253,684	34,983	307,317	40,804	277,188	69,542
Total	4,953,952	598,199	5,231,252	842,916	5,462,637	1,462,531

Imported from—	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	58,123	$18,172	735,870	$102,516	203,021	$27,727
Belgium	394,168	78,176	466,990	67,299	103,763	11,275
France	418,661	98,833	80,633	13,748	21,972	2,812
Germany	1,296,095	334,047	1,052,527	185,790	195,199	46,384
Italy	53,072	14,074	45,174	6,168	379,252	78,183
Netherlands	60,601	14,008	36,151	4,347	264,585	54,117
Russia in Europe	1,212,654	227,685	2,098,374	332,911	.....	.....
United Kingdom	1,274,710	315,285	1,098,767	165,458	1,060,446	232,110
Canada	49,503	11,937	57,419	9,440	51,643	10,665
All other	267,662	71,685	130,455	22,082	1,032,342	238,553
Total	5,085,249	1,183,902	5,802,360	910,759	3,312,223	701,826

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	.....	.....	84,668	$17,687	.....	.....
Belgium	.....	.....	.....	.....	.....	.....
France	420,570	$128,302	47,615	15,368	.....	.....
Germany	.....	.....	.....	.....	.....	.....
Italy	125,883	43,239	30,275	14,743	.....	.....
Netherlands	352,306	119,545	109,841	53,430	46,172	$19,493
Russia in Europe	.....	.....	35,274	15,424	84,388	41,351
United Kingdom	907,971	284,109	995,133	382,016	422,133	180,008
Canada	32,359	12,275	18,253	10,337	894,053	231,591
All other	297,815	102,492	296,548	120,245	159,782	74,146
Total	2,136,904	689,962	1,617,607	629,250	1,606,528	546,589

Fusel oil or amylic alcohol—imports for consumption—revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	½ cent per pound	4,783,145	$575,296	$11,958	$0.120	2.07
1908	do	4,452,524	652,130	11,131	.150	1.71
1909	do	3,560,261	441,982	8,909	.124	2.01
1910	do	4,970,538	599,909	12,426	.121	2.07
1911	do	5,176,344	839,460	12,940	.162	1.54
1912	do	5,468,554	1,464,031	13,671	.268	.93
1913	do	5,116,660	1,183,872	12,791	.231	1.08
1914	do	5,679,750	888,844	14,199	.156	1.60
1915	do	3,298,228	699,512	8,245	.212	1.18
1916	do	2,162,617	695,196	5,406	.321	.78
1917	do	1,612,297	629,099	4,030	.390	.64
1918	do	1,606,528	546,589	4,016	.340	.73
1919	do	1,464,500	386,416	3,881	.264	1.04

Fusel oil—Prices per gallon, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

CRUDE.

Jan. 1, 1912	$2.50	Apr. 3, 1916	3.75- 4.00
Apr. 1, 1912	$2.40- 2.60	July 3, 1916	4.50- 6 00
July 1, 1912	2.40- 2.50	Oct. 2, 1916	4.10- 4.25
Sept. 30, 1912	2.40- 2.50	Jan. 1, 1917	3.50- 3.75
Dec. 30, 1912	2.30- 2.40	Oct. 1, 1917	4.50
Mar. 31, 1913	2.05- 2.10	Dec. 31, 1917	4.50
June 30, 1913	1.50- 2.00	January, 1918	4.50
Sept. 29, 1913	1.35- 1.60	April, 1918	4.00- 4.15
Dec. 29, 1913	1.25- 1.50	July, 1918	3.30- 3.50
Mar. 30, 1914	1.15- 1.20	October, 1918	3.30- 3.50
June 29, 1914	1.05- 1.15	January, 1919	2.50- 2.60
Sept. 28, 1914	1.75- 1.80	April, 1919	2.00- 2.50
Dec. 28, 1914	2.20- 2.30	July, 1919	2.25- 2.50
Mar. 29, 1915	2.25- 2.30	October, 1919	2.25- 2.50
June 28, 1915	2.25- 2.30	January, 1920	2.25- 2.50
Sept. 27, 1915	2.75- 3.00	April, 1920	Nominal.
Jan. 3, 1916	3.45- 3.70	July, 1920	Nominal.

REFINED.

Jan. 1, 1912	$3.00-$3.25	Apr. 3, 1916	$4.75-$5.00
Apr. 1, 1912	2.90- 3.00	July 3, 1916	6.25
July 1, 1912	2.90- 3.10	Oct. 2, 1916	5.25- 5.50
Sept. 30, 1912	2.75- 3.00	Jan. 1, 1917	3.85- 4.00
Dec. 30, 1912	2.65- 3.00	Oct. 1, 1917	5.25- 5.35
Mar. 31, 1913	2.40- 2.50	Dec. 31, 1917	5.25- 5.35
June 30, 1913	2.25- 2.30	January, 1918	5.25- 5.35
Sept. 29, 1913	2.25- 2.30	April, 1918	5.75- 6.00
Dec. 29, 1913	1.80- 1.90	July, 1918	5.75- 6.00
Mar. 30, 1914	1.65- 1.70	October, 1918	5.75- 6.00
June 29, 1914	1.60- 1.65	January, 1919	4.25- 4.50
Sept. 28, 1914		April, 1919	3.75- 3.80
Dec. 28, 1914	2.75	July, 1919	3.85- 4.00
Mar. 31, 1915	2.85- 3.00	October, 1919	3.85- 4.00
June 28, 1915	3.25- 3.35	January, 1920	3.85- 4.00
Sept. 27, 1915	3.75- 4.00	April, 1920	5.00- 6.00
Jan. 3, 1916	5.25- 5.75	July, 1920	5.00- 6.00

Fusel oil or amylic alcohol—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	112	Amylic alcohol, or fusel oil	10 per cent ad valorem.
1890	42	Fusel oil, or amylic alcohol	Do.
1894	30	.....do	Do.
1897	38	.....do	¼-cent per pound.
1909	36	.....do	Do.
1913	33	.....do	Do.

COURT AND TREASURY DECISIONS.

A mixture of alcohols other than ethyl, in which the boiling point of the several components varied from 85° to 100° C., and differing from the fusel oil of commerce in color and odor, was held not to be dutiable as fusel oil or amylic alcohol under the act of 1890 (G. A. 2065; T. D. 13960). This decision was followed under the act of 1897, the term "fusel oil" being restricted to such as was known to commerce at the time of the passage of that act. (Dept. Order, T. D. 20357.)

BUTYL ALCOHOL.

General Information.

Butyl alcohol is not mentioned specifically in the tariff act of 1913, but has been declared dutiable as fusel oil or amylic alcohol by similitude under paragraph 33 at one-fourth cent per pound. (T. D. 37577.)

Description and uses.—Butyl alcohol ($C_4H_{10}O$) occurs in four isomeric forms. Of these four forms, normal butyl alcohol is the only one of any commercial importance. Chemically it is also known as propylcarbinol ($C_2H_5CH_2—CH_2OH$). The normal butyl alcohol is a limpid, colorless, and highly refractive liquid which possesses an agreeable vinous odor. The commercial product, according to specifications of the Commercial Solvents Corporation, the only domestic manufacturers, has a specific gravity of 0.810 to 0.814 at 15° C., and 80 to 100 per cent boils between 115° and 117° C.

The principal use of butyl alcohol is as a solvent in the manufacture of pyroxylin plastics. It is also used as a preventative of "blushing," and precipitation of pyroxylin in photographic films, lacquers, and other pyroxylin varnishes. It may also be used for other solvent purposes, such as the manufacture of paint and varnish removers, imitation leather, and as a solvent for gum resins, fats, oils, and waxes.

In the manufacture of pyroxylin plastics butyl alcohol is competitive with fusel oil or amylic alcohol, which has been largely imported, chiefly from Russia. (See survey on fusel oil or amylic alcohol.)

Domestic production.—Prior to the war butyl alcohol was only of scientific interest and was not used for commercial purposes. A large war demand for acetone led to the development of a fermentation process which produced both acetone and butyl alcohol from shelled corn. In order to supply the large and profitable demand for acetone, great quantities of butyl alcohol were produced during the war without a market for it. These products are obtained in the ratio of about 2 parts butyl alcohol to 1 part acetone. During the war a plant was established at Terre Haute, Ind., which was owned and operated during the war by the United States and British Governments under the name of the Commercial Solvents Co. Following the signing of the armistice this plant was closed down, as at that time there was no market for butyl alcohol and the demand for acetone had ceased.

In December, 1919, the Commercial Solvents Corporation was organized and this company purchased the plant at Terre Haute and reopened it in March, 1920. The ability of the plant to operate at the present time is due to recent developments for the use of butyl acetate made from butyl alcohol or the butyl alcohol itself in the manufacture of pyroxylin plastics.

The output of the combined solvents (acetone, butyl alcohol, and ethyl alcohol) during the latter part of 1920 amounted to about 1,000,000 pounds per month. The raw material, shelled corn, is first thoroughly sterlized and then fermented by means of bacteria (*Bacillus butylicus*). The products obtained from this fermentation are about 10 parts of ethyl alcohol, 60 of butyl alcohol, and 30 parts of acetone. These products are separated by fractional distillation before being put on the market. This process of producing butyl alcohol is known as the Weizmann process and is covered by United States patents, which are owned by the Commercial Solvents Corporation.

Foreign production.—Acetone and butyl alcohol were produced by this process during the war by the British Acetone Co., at Toronto, Canada. The production of acetone by this process in Canada had reached 200 tons per month at the close of the war. On the basis that two parts of butyl alcohol are produced for one part of acetone, this would represent a production of 400 tons of butyl alcohol per month. A plant to convert butyl alcohol into ethyl methyl ketone, which was a satisfactory solvent for the British explosive cordite, had just commenced operation at the signing of the armistice. This plant for production of acetone has been closed since the signing of the armistice.

Imports into the United States.—Imports of butyl alcohol are not shown separately in Commerce and Navigation. In recent years (1919) imports have been combined with fusel oil, or amylic alcohol. During 1914, Pickrell shows that only 482 pounds of butyl alcohol, with a value of $287, were imported from Germany.

Prices.—Butyl alcohol has not been quoted in the technical journals prior to August, 1920. Prices, since then, during 1920, have been practically constant at 33 to 40 cents per pound (about $2.20 per gallon).

Tariff history and consideration.—Butyl alcohol has not been mentioned by name in the tariff acts. A recent ruling of the Treasury Department (see T. D. 37577, infra) classifies butyl alcohol as fusel oil or amylic alcohol by similitude at one-fourth cent per pound under paragraph 33, act of 1913. Butyl alcohol is competitive with fusel oil as a solvent in the manufacture of pyroxylin and is used for many of the purposes for which fusel oil has been employed in the past. In view of the present practice in classification of butyl alcohol and the fact that it is assuming importance in commerce and industry, it would be well to provide for it by name in paragraph 33 along with fusel oil or amylic alcohol. The paragraph might then read as follows:

"33. Butyl alcohol (rate); fusel oil or amylic alcohol (rate)."

Butyl alcohol—Prices (wholesale), spot, New York, market.

[From Oil, Paint, and Drug Reporter.]

1920.[1]	Cents per lb.[2]
August	33-40
September	33-40
October	33-40
November	33-40

[1] Not quoted prior to August, 1920.

[2] Unit not given in connection with quotations, (See letter of Nov. 22, 1920, from Oil, Paint and Drug Reporter.)

COURT AND TREASURY DECISIONS.

A mixture consisting mainly of butyl alcohol, with a considerable quantity of propyl alcohol and a little amyl alcohol, the residual product from fusel oil "after amyl alcohol has been removed or * * * a product obtained like fusel oil by the control of the fermentation process and the character of the ferment used," and used principally as a solvent for nitrocellulose in the making of cheap lacquers, was held by the Treasury Department dutiable by similitude in use as fusel oil or amylic alcohol under paragraph 33 by virtue of paragraph 386 of the act of 1913. . . (T. D. 37577, of 1918.)

The Board of General Appraisers subsequently held such merchandise, which the collector had classified as a chemical compound under paragraph 5 of that act, or as enumerated unmanufactured article under paragraph 385, to be dutiable under paragraph 33 as fusel oil upon proof that fusel oil is a varying mixture containing both amyl and butyl alcohols as its principal ingredients. (G. A. 8288, T. D. 38144, of 1919; Abstract 43906, of 1920.)

GLUE, GELATIN, ISINGLASS, AND AGAR-AGAR.

[Par. 34, act of 1913.]

SUMMARY.

Paragraph 34: "Gelatin, glue, and glue size, valued not above 10 cents per pound, 1 cent per pound; valued above 10 cents per pound and not above 25 cents per pound, 15 per cent ad valorem; valued above 25 cents per pound, 25 per cent ad valorem; manufactures of gelatin or manufactures of which gelatin is the component material of chief value, 25 per cent ad valorem; isinglass and prepared fish sounds, 25 per cent ad valorem; agar-agar, 20 per cent ad valorem."

Glue is an organic substance of varying chemical composition obtained from animal matter by extraction with water. Gelatin is made from some of the same materials as glue, but special care is used in selecting, washing, and treating these materials, so that the final product is much purer and cleaner than glue. Broadly speaking, glue is impure gelatin or gelatin may be considered as pure glue. Other preparations which possess adhesive properties similar to glue are loosely called glues. Recent customs decisions have held that an article to be classed as glue must come within what is commonly known in commerce as glue, a preparation consisting chiefly of gelatin.

Isinglass is prepared from the sound or swimming bladder of the sturgeon or other fish. The principal ingredient of isinglass—collagen—is converted into gelatin on boiling with hot water. Russian isinglass is the most valued grade.

Agar-agar (commonly called Bengal or Japanese isinglass) is a dried sea weed obtained largely from Singapore. It is the only vegetable product included in paragraph 34. It is used chiefly in the preparation of culture media for bacteria.

The manufacture of glue consists in cleaning the stock, boiling the stock with water, clarification of the glue solution, evaporation, allowing the solution to cool and "jelly," cutting into strips, and drying. The manufacture, although requiring considerable care in certain stages, is nevertheless simple compared with the production of other chemical products.

The total production of glue and gelatin for 1914 was valued at $19,725,703, 70 per cent was produced by primarily glue manufacturers and 16 per cent by slaughtering and meat-packing concerns. The total capitalization of 57 establishments engaged primarily in the manufacture of glue and gelatin in 1914 was $17,162,000, with a production valued at $13,733,000. The domestic production supplies over 85 per cent of the consumption. In 1914 when the imports of glue and gelatin were three times the normal import, they amounted to 13 per cent of the value of the domestic production. The exports of glue were fairly constant from 1910 to 1915, inclusive, and averaged about 2,600,000 pounds annually. The value of the exports of

glue in 1914 was 1.3 per cent of the domestic production of *glue and gelatin*. The exports during the war increased to about 5,000,000 pounds.

The duty on glue and gelatin since the passage of the act of 1897 has been made dependent on the value of the product imported. This division by value during the prewar period separated glue and gelatin into distinct classes, but during the war with the increase in prices the separation of the various grades was considerably changed. It is a question whether this classification serves any useful purpose either to the Government or to the domestic producer. It seems that it would be more logical to levy an ad valorem duty on all glue and gelatin in view of the numerous grades and make no distinction as to valuation, and as there are no reliable methods of chemical analysis on which to base a separation of glue and gelatin into various commercial grades. The manufacturers argue that an ad valorem duty would not protect the lower grades of glue which are the bulk of imports. This contention could be met by a compound duty.

Glue and gelatin—Summary table (fiscal years).

Year.	Imports for consumption.	Domestic exports.[1]	Ratio to production.	
			Imports.	Exports.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
1910	7,654,658	2,488,205	.....	.....
1911	9,417,716	2,307,966	.....	.....
1912	8,068,149	3,059,952	.....	.....
1913	7,185,601	2,544,942	.....	.....
1914	24,940,908	2,351,773	[3] 13	1.31
1915	10,794,645	2,874,225	.....	.....
1916	4,687,638	4,946,228	.....	.....
1917	7,260,231	4,064,231	.....	.....
1918	2,382,427	4,901,764	.....	.....
1919	[2] 487,617	7,283,733	.....	.....
1920	.....	13,141,294	.....	.....
1918 [4]	821,853	5,809,605	.....	.....
1919 [4]	1,347,612	8,486,167	.....	.....
1920 [5]	1,641,670	12,449,799	.....	.....

[1] Exports are of glue only, gelatin not shown in Commerce and Navigation.
[2] Glue and glue size.
[3] Percentages calculated on valuation.
[4] Calendar year.
[5] 6 months ending June 30, 1920.

Glue—Summary table (fiscal years).

Year.	Imports for consumption.	Domestic exports.	Year.	Imports for consumption.	Domestic exports.
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
1910	6,415,265	2,488,205	1917	6,292,311	4,064,231
1911	8,089,746	2,307,966	1918	2,013,312	4,901,764
1912	7,366,641	3,059,952	1919	487,617	7,283,733
1913	6,099,661	2,544,942	1920	.....	13,141,294
1914	22,501,468	2,351,773	1918 [1]	741,778	5,809,605
1915	8,086,283	2,874,225	1919 [1]	900,047	8,486,167
1916	3,030,573	4,946,228	1920 [2]	801,783	12,449,779

[1] Calendar year.
[2] 6 months ending June 30, 1920.

General Information.

DESCRIPTION.

Paragraph 34. "Gelatin, glue, and glue size, valued not above 10 cents per pound, 1 cent per pound; valued above 10 cents per pound and not above 25 cents per pound, 15 per cent ad valorem; valued above 25 cents per pound, 25 per cent ad valorem; manufactures of gelatin or manufactures of which gelatin is the component material of chief value, 25 per cent ad valorem * * *."

Glue is an organic substance of varying chemical composition which is obtained by extraction with water from properly prepared animal matter, such as skins and bones. In commerce glue appears in various forms, in rectangular sheets or cakes (sheet or cake glue), in wide or narrow strips (ribbon or noodle glue), in broken flakes (flake or, in England, chip glue), and ground or granulated in all degrees of fineness (ground or powdered glues). It is sometimes nearly colorless and transparent, sometimes opaque, and it occurs in all shades of white, yellow, and brown. Opaque and colored glues are made by adding some pigment or whiting, and are used chiefly in Europe.

Gelatin is made from some of the same materials as glue, but especial care is exercised in selecting, washing, and treating these materials, so that the final product is much cleaner and purer than glue. Broadly speaking, glue is impure gelatin or gelatin may be considered as pure glue. Some very light-colored high-test glues so closely resemble gelatin that it is difficult to differentiate between them.

Other preparations which possess adhesive properties similar to those of glue are loosely called glues. Examples of these are marine glue, a resinous preparation, starch and dextrin glues, and caseins glues (see T. I. survey on dextrin and caesin). Strictly speaking, they have no claim to the name glue, as they contain no gelatin. However, they are competitive with gelatin glues, especially casein glues, which were used largely during the war in the manufacture of aeroplanes. It is possible to make a waterproof glue, using casein, and casein glues may offer considerable competition to gelatin glues. The classification of these preparations has varied, but the recent decisions of the courts have held that an article to be classified as glue must come within what is commonly known in commerce as glue, a preparation consisting chiefly of gelatin.

Glue or gelatin is probably not present as such in the raw animal material but is rather a product of the hydrolysis (action of water) of various nitrogenous tissues. Comparatively little is known regarding the chemical composition of gelatin and still less of the composition of the more impure product, glue. This fact makes it difficult to divide glue into various grades by chemical specifications and accounts for the division according to valuation in the tariff acts.

The ordinary methods used in testing glues are based largely on their physical properties, chiefly viscosity and "jelly strength." The experience of the individual is essential in this method. A glue expert by mere observation of the physical action of glue under certain conditions will reach more reliable conclusions as to the quality of the glue than by chemical analysis. The best and most

reliable test for glue is an actual test under the conditions for which it is intended to be used.

Glue size may be considered as a by-product of the manufacture of glue. It usually consists of crude glue liquors which are obtained by a third or fourth extraction of the raw materials, and which if dried would give a glue of inferior quality. As usually sold, it contains from 25 to 38 per cent of glue.

DOMESTIC PRODUCTION.

Materials.—The materials used for the manufacture of glue, known commercially as glue stock, may be divided into four general classes as follows:

1. Hide or skin.
2. Bone.
3. Sinew.
4. Fish stock.

Most of the hide stock is produced by tanners as a waste product. "Pieces" or heavy trimmings from dried, salted, or limed hides yield 18 to 50 per cent of glue; "fleshings" or scrapings from the flesh side of hides yield 3 to 40 per cent of glue; "skivings," which are parings from the hair or grain side are also used. A great variety of skins and hides are used as glue stock.

A number of kinds of commercial glue stocks are produced from bone tissues. Green or packer bone consists of fresh sweet bone containing the marrow. Such stock usually undergoes preliminary steaming at point of production to separate the fat, and incidentally the keeping qualities of the bone are so improved that it will stand transportation and storage. The hoofs and horns are removed as they yield no glue at all. Country bone, chiefly butchers' offal, and "junk bone," consisting of old dry bone from any source are used mostly in the production of low-grade glues. Ossein stock or acidulated bone is the residue of bone after the mineral matter has been dissolved out by acid. It is also made from button makers' scrap bone and is then known as "dentelles."

Sinews come into the glue-stock market fresh or green salted from slaughterhouses. They are also imported from South America.

The heads, bones, skins of fish and fish offal yield glue, which is usually the liquid glues. They possess good adhesive properties but are very evil smelling.

Methods of production.—The operations in the manufacture of glue may be grouped under three heads:

A. Preparing the stock.
B. Boiling the stock or extracting the glue.
C. Treating and drying the glue solution.

The preparation of the stock is the only class of operation which varies according to the material used. The other two operations are substantially the same for all stock.

A. *Preparing the stock.*—When bone containing fat is used, it is first treated to remove any grease. This may be accomplished by heating or steaming, but is sometimes done by extraction with a volatile solvent. The bone thus prepared is then crushed and is ready for the boiling operation. Hides, sinews, and ossein after a preliminary soaking or washing to soften them and remove salt and

foreign materials are placed in baths of lime water (liming or plumping). This treatment swells the stock and makes it soft and "plump," so that it dissolves readily on boiling. The limed stock is then washed free from lime, a very weak acid solution being used for the last wash.

B. *Boiling the stock.*—The prepared stock is now subjected to the action of hot water, by which the material is converted into glue and the resulting glue extracted from the stock. A short extraction and at as low a temperature as possible produces the best grade of glue. The different types of stock necessitates the use of various types of kettles or cookers, which may be grouped into "open tanks" and "pressure tanks." The open tanks are largely used for boiling hide, sinew, and ossein stocks, while the pressure tanks are used for the boiling of untreated bone.

C. *Treating and drying the glue solution.*—The glue solution, if necessary, is clarified by various methods. The clear glue solution is then evaporated under reduced pressure if it is not already of the proper concentration. The concentrated glue solution then may be bleached if necessary. The glue liquors are then run into galvanized coolers where the solution sets to a "jelly." The blocks of glue jelly are then removed from the coolers and cut by a wire knife, operated either by hand or mechanically, into the desired thickness. These sheets are spread on galvanized or linen nets and high piles of the nets (stacks) are run into a dry room against first a current of cool air and then a current of warmer air. As the drying progresses and the glue "skins over" it is moved nearer the heating coils, in front of which it receives a final drying. The dried glue is then removed from the dry room, broken or ground, and packed for shipment. The drying of the glue is the most important operation in the manufacture of glue, and especial care must be exercised in this operation to obtain glue of the proper quality.

Organization.—The total capitalization of the 57 establishments engaged primarily in the manufacture of glue in 1914 was $17,162,000. The product of these firms was valued at $13,753,000. Of this value 80 per cent was produced in the States of Illinois, Massachusetts, New York, and Pennsylvania. These firms furnished employment to an average of 3,129 wage earners. Glue to the value of $5,992,879 was produced by firms engaged primarily in other manufacture, making a total production of $19,725,703. The following table shows the distribution of the total value by kind of establishments:[1]

	Value.	Total.
		Per cent.
Primarily glue manufacturers	$13,733,000	69.6
Slaughtering and meat packing	3,088,764	15.7
Fertilizer manufacturers	1,131,243	5.75
Miscellaneous[1]	1,772,872	8.95
Total	19,725,879	100.00

[1] Includes principally establishments making sand and emery paper and cloth, tallow, soap stock, food preparations, oleo oil, and fish oil.

Domestic production and consumption.—The total production of glue and gelatin in 1914 was valued at $19,725,703; the quantity is not

[1] Compiled from "Abstracts of the Census of Manufacturers, 1914," Department of Commerce.

available. The domestic production supplies at least 85 per cent of our consumption. In 1914 with the import of glue and gelatin about three times as great as in former years, the import was about 13 per cent of our domestic production. In addition about 1.3 per cent of the domestic production was exported. (Percentages are based on values.

Exports.—The export of glue from 1910 to 1915, inclusive, averaged about 2,600,000 pounds per year. The quantity exported since has increased sharply to between four and five million pounds. The export in 1914 (based on valuation) was 1.3 per cent of the domestic production of glue and gelatin. The chief consumers were the United Kingdom, Germany, and Canada. Since 1915 Cuba, Japan, and China have been taking large quantities of glue.

Exports of gelatin are not shown in Commerce and Navigation.

Imports.—The imports of glue from 1910 to 1913, inclusive, have been between six and eight million pounds. In 1914 the import increased to over 22,000,000 pounds. The combined import of glue and gelatin in 1914 was 13 per cent of the domestic production of glue and gelatin (based on value). The import of glue since has decreased until in 1918 a little over 2,000,000 pounds were imported. Prior to 1915 Germany furnished about one-third of the imports of glue. Belgium, France, United Kingdom, and Austria-Hungary supplied the larger part of the remainder. Since 1914 there has been, with a few exceptions, a general decrease in imports from all European countries. Considerable quantities of glue have been imported from Chile since 1915.

The imports of gelatin prior to 1914 averaged a little over 1,000,000 pounds. In 1914 and 1915 over 2,000,000 pounds were imported. The imports then decreased until in 1918 they were less than 400,000 pounds.

PRICES.

The price of glue was practically constant until in 1917. The pre-war price of "common bone" was 7½ to 9 cents per pound and of "foot stock white" was 12 to 14 cents per pound. In January prices increased about 50 per cent and by January, 1918, the price had increased to about twice the existing prewar price. In the early part of 1918 there was a general trend downward in the price of the less expensive glues, until in the last half of 1919 the prices were between 25 and 50 per cent higher than the prewar price. In the higher priced glues there was practically no decrease in the price during 1918 and 1919.

TARIFF HISTORY AND CONSIDERATIONS.

The duty on glue and gelatin during the act of 1890 and since the passage of the act of 1897 has been dependent on the value of the product imported. The acts beginning with 1897 divided the commodities into three classes as follows: (1) Glue and gelatin valued not above 10 cents per pound. The rate of duty in the 1897 and 1909 acts was 2½ cents per pound, and in the act of 1913 the duty was reduced to 1 cent per pound. (2) Glue and gelatin valued above 10 cents per pound but not above 35 cents per pound in the acts of 1897 and 1909. The upper limit of this class was reduced at 25 cents per pound by the act of 1913. The duty on this class was 25

per cent ad valorem in the acts of 1897 and 1909, and 15 per cent in the act of 1913. (3) Glue and gelatin valued above the upper limit specified in class 2. The duty on this class under the acts of 1897 and 1909 was 15 cents per pound and 20 per cent ad valorem, and under the act of 1913 the duty was 25 per cent ad valorem.

This classification, prior to the war, made the bulk of the glue imported fall in class 1, practically all of the remainder in class 2, and practically none in class 3, while the bulk of the gelatin imported fell in class 2, the greater part of the remainder in class 3, and less than 1 per cent in class 1.

The effect of the increase in the price of glue and gelatin on the relative quantities that fall in the various classes of the tariff act is shown in the following table. The prewar period of 1910 to 1913, inclusive, is compared with only 1917 and 1918 as the price of glue and gelatin showed no appreciable increase until 1917.

[Per cent of total.]

Class.	Glue.		Gelatin.	
	1910–1913	1917–18	1910–1913	1917–18
1	60.64	16.28	0.71	0.13
2	39.34	74.72	71.45	14.62
3	.02	9.00	27.84	85.25
	100.00	100.00	100.00	100.00

The bulk of glue in 1917–18 fell in class 2, with a slight advance in duty equivalent to about 4 per cent ad valorem. The increase was due to a specific duty on class 1, which, with the increase in price, caused a decrease in the equivalent ad valorem on class 1. On a normal price basis shown by the years 1915 and 1916 the specific duty of 1 cent per pound on the class 1 is equivalent to about 15 per cent ad valorem, which is the duty levied on class 2. The duty increase on the quantity that fell in class 3 instead of class 2 by virtue of the increased price was 10 per cent ad valorem.

In the case of gelatin the quantity falling in class 1 is negligible under even normal conditions. The effect of the increase in price of gelatin was to throw the bulk of the imports into class 3 instead of class 2 at an increase in duty of 10 per cent ad valorem.

It is a question whether the classification of glue and gelatin according to the above three divisions serves any useful purpose either to the Government or to the domestic producer. The manufacturers have argued that greater protection is necessary for the higher grades and higher-priced glues, and therefore recommend an ad valorem duty.[1] The present duties on class 1 and class 2 with normal price conditions are about equal (see imports in 1915 and 1916), so that the division here serves no purpose and the two classes could be combined without changing the relative rates of the two groups. During the period covered by the act of 1909 the specific duty of 2½ cents per pound on class 1 was equal to about 35 per cent ad valorem as compared with a duty of 25 per cent ad valorem on class 2, which does

[1] Statement of National Association of Glue and Gelatin Manufacturers. Tariff hearings, Ways and Means Committee, 1913.

not agree with what the manufacturers claimed was necessary, namely a higher duty on the higher grades.

It might be more logical to levy an ad valorem duty on all glue and gelatin in view of the numerous grades and difficulty of distinguishing between high grades of glue and gelatin and as there are no reliable methods of analysis on which to base a separation of glue into the various commercial grades; the duty would then increase in proportion to the price of the various grades. The manufacturers argue that an ad valorem duty would not protect the lower grades of glue which are the bulk of imports. This contention could be met by a compound duty.

ISINGLASS.

Isinglass[1] is a preparation of the "sound" or swimming bladder of the sturgeon and other fish. It should be white, with a yellowish tinge, semitransparent, fibrous, and tenacious. When pure it has no odor and only a faint taste. The commercial product contains from 15 to 20 per cent of moisture. It consists of fibers or threads which, when immersed in water, swell up but retain their structure, and it is to this property that the use of isinglass for clarifying wine, beer, and other liquids is partially due.

The principal ingredients of isinglass is collagen, which is converted into gelatin on boiling with water.

Russian isinglass is the most valued kind, its solution having a higher viscosity than any other variety. It is obtained from various varieties of sturgeon which inhabit the Volga, Caspian, and Black Seas and the Arctic Ocean. The other sources of supply are Hudson Bay territory, Brazil, West Indies, Penang, Bombay, and Manila.

The imports of "isinglass and prepared fish sounds" decreased from 85,896 pounds, valued at $36,642, in 1914 to 11,906 pounds, valued at $9,008 in 1915. Imports have increased since to between 30,000 and 35,000 pounds in 1917 and 1918. Pickerell[2] shows that in 1914, 90 per cent of the isinglass imported came from Japan.

The price of Russian isinglass increased from about $3.50 per pound in the third quarter of 1914 to $7.50 per pound in the second quarter of 1916; then declined to $4 per pound in January, 1918. From this time the price increased rapidly to a maximum of $10 per pound during the last half of 1919. The price of American isinglass increased only slightly during the war and was quoted generally at 75 to 80 cents per pound. Quotations are not available for the last part of 1918 and for 1919.

AGAR-AGAR.

Agar-agar (commonly called Bengal or Japanese isinglass) is a dried seaweed obtained largely from Singapore. It occurs in transparent strips or in shorter and thicker yellowish-white pieces. It is insoluble in cold water but soluble in hot water. The solution of agar-agar on cooling forms a thick gelatinous jelly. The jelly produced by agar-agar does not melt as readily as that from gelatin. It is chiefly used for culture media for bacteria. It is also used as a

[1] It is a common error to call the mineral mica "isinglass," probably due to its transparency and flexibility.

[2] Pickerell, Dr. E. R.: "Chemicals and Allied Products Used in the United States," Department of Commerce, Miscellaneous Series, No. 82.

thickening agent in milk, cream, and ice cream, and as a substitute for egg white. Agar-agar differs from the other products in paragraph 34, as it is a vegetable product instead of an animal product.

Imports of agar-agar increased from 189,199 pounds, valued at $54,284, in 1914 to 431,622 pounds, valued at $162,527 in 1917. In 1918 the imports decreased to about one half of the 1917 importation.

The price of agar-agar No. 1 declined from 48 to 65 cents per pound in the last quarter of 1914 to 33 to 50 cents per pound in the last quarter of 1915 in spite of war conditions. The price then increased until in January, 1919, a maximum of 90 to 95 cents per pound was reached. There was only a slight decrease in price during 1919.

Glue and gelatine—Production in United States—"Official source."

1909	$16,328,579
1914	19,725,703

Hide cuttings, raw, and other glue stock (free)—Imports by countries.

FISCAL YEARS.

Imported from—	1910	1911	1912	1913	1914	1915
Belgium	$116,115	$114,297	$202,988	$152,830	$185,499	$46,261
France	190,814	212,744	228,164	231,805	310,812	235,642
Germany	273,667	179,813	275,985	250,508	455,207	170,661
Italy	197,106	234,769	189,777	203,849	235,841	147,949
United Kingdom	521,908	474,349	391,892	494,913	391,722	392,284
Canada	23,682	37,202	61,943	48,658	71,211	84,699
Argentina	44,311	82,437	53,049	62,884	116,545	105,760
British India	107,891	72,621	110,693	174,784	216,351	194,474
All other	129,938	224,810	192,680	147,151	175,326	132,878
Total	1,605,432	1,633,042	1,707,171	1,767,382	2,158,514	1,510,608

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France		$89,542	2,063,677	$76,299	712,149	$30,957
Germany		10,888				
Italy		178,544	9,817,161	408,784	5,110,978	245,914
United Kingdom		355,933	4,413,090	433,882	1,049,864	142,536
Canada		50,302	4,151,495	105,882	4,745,157	148,981
Argentina		109,590	6,873,981	234,101	4,674,213	203,370
British India		55,303	352,916	8,622	417,358	13,806
Uruguay		26,538	3,409,550	83,851	3,623,454	82,653
All other		95,466	2,547,837	100,852	1,377,032	68,176
Total		972,106	33,629,707	1,452,273	21,710,205	936,393

CALENDAR YEARS.

Imported from—	1918		1919		1920 [1]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium			22,444	$3,710		
France	140,368	$18,630	250,764	23,884		
Italy	2,862,652	137,189	1,662,476	104,341		
United Kingdom	214,633	17,428	2,300,682	482,914		
Canada	3,640,107	155,264	5,612,979	199,297		
Argentina	1,296,127	73,899	487,445	8,275		
British India	119,803	1,035	1,548,417	60,695		
Uruguay	541,907	23,010	1,201,578	57,279		
All other	567,032	28,393	693,852	38,119		
Total	9,381,629	454,838	13,780,637	978,514	29,116,717	$1,802,233

[1] 10 months ending Oct. 31, 1920. Not stated by countries.

Manufactures of gelatin—imports by countries.

FISCAL YEARS.

Imported from—	1910	1911	1912	1913	1914	1915	1916	1917	1918
Austria-Hungary	$3,042	$3,993	$15,857	$14,888	$2,681	$109	.....	.....	.....
France	5,100	2,956	2,255	5,981	50,885	47,086	$11,832	$5,084	$2,513
Germany	22,745	55,000	309,643	396,940	55,515	29,252	9,792	.....	.....
Switzerland	.....	6,997	39,675	38,716	2,426	38	543	35	.....
United Kingdom	4,742	15,870	26,669	41,188	23,829	14,025	14,524	21,255	7,378
All other	221	100	88	1,084	38	803	542	[1]11,951	333
Total	35,850	84,916	394,187	498,797	135,374	91,313	37,233	38,275	10,224

[1] Includes $11,347 from Belgium. Not shown after 1918.

Gelatin—Imports by countries.

FISCAL YEARS.

Imported from—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	130,213	$22,312	315,812	$54,588	139,950	$24,213
France	118,709	14,508	136,173	20,229	116,411	16,281
Germany	753,903	268,035	576,938	223,512	354,015	103,901
Switzerland	67,780	34,097	143,351	48,555	44,804	6,168
United Kingdom	156,923	41,452	120,784	30,680	104,780	26,593
All other	22,328	6,292	14,921	4,561	24,008	4,305
Total	1,249,856	386,696	1,312,979	387,525	783,668	181,461

Imported from—	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	170,024	$30,682	256,839	$47,322	268,024	$48,020
France	169,204	27,779	529,761	100,100	377,747	70,517
Germany	644,346	206,152	1,366,815	493,033	1,410,361	521,875
Switzerland	94,843	29,127	157,041	66,187	146,842	63,435
United Kingdom	75,308	18,740	109,118	25,121	272,352	61,593
Netherlands	.....	.....	.....	.....	223,416	47,371
All other	16,357	2,121	21,743	6,968	15,487	3,710
Total	1,170,082	314,601	2,441,317	738,731	2,714,229	816,521

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	132,201	$30,399	199,677	$72,484	55,031	$21,939
Germany	559,800	246,351	.....	.....	.....	.....
Switzerland	49,511	18,314	11,262	6,866	7,714	8,250
United Kingdom	182,532	50,318	212,740	78,287	126,683	44,173
Netherlands	675,752	156,060	668,928	193,974	153,339	52,860
All other	439	67	22,060	7,465	22,819	5,835
Total	1,600,235	501,509	1,114,667	359,076	365,586	133,057

Gelatin—Imports by countries—Continued.

CALENDAR YEARS.

Imported from—	1918		1919		1920 [1]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	39,597	$16,114	10,980	$6,245	.....	.....
Switzerland	488	558	24,122	22,511	.....	.....
United Kingdom	42,448	15,590	83,460	43,064	.....	.....
Canada	43	29	294	215	.....	.....
Japan	190	62	2,107	1,093	.....	.....
All other	.....	.....	328,377	168,707	.....	.....
Total	82,766	32,353	449,336	241,835	1,905,976	$1,013,527

[1] 10 months ending Oct. 31, 1920. Not stated by countries.

Glue—Imports by countries (fiscal years).

Imported from—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	712,416	$70,888	577,524	$40,814	425,017	$31,077
Belgium	599,834	75,648	536,730	72,156	893,792	133,802
France	1,811,589	218,660	1,827,014	233,154	1,758,586	236,002
Germany	2,173,733	187,292	2,537,342	222,107	2,113,269	183,537
Italy	6,578	560	6,646	438	179,975	12,381
Netherlands	8,450	1,008	46,516	3,106	8,918	615
Switzerland	.....	.....	15,509	828	.....	.....
United Kingdom	3,491,980	305,828	2,740,345	230,025	2,081,959	173,074
All other	16,974	2,004	47,552	3,580	62,806	6,208
Total	8,821,554	861,888	8,335,178	806,208	7,534,322	776,696

Glue and glue size—Imports by countries.

FISCAL YEARS.

Imported from—	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	343,314	$21,393	5,440,234	$358,722	574,716	$44,457
Belgium	1,222,752	186,030	1,183,357	148,976	1,567,689	233,315
France	1,643,874	220,433	2,780,824	287,257	1,178,818	133,105
Germany	2,091,173	193,754	7,051,952	558,858	1,037,352	78,371
Italy	66,138	4,053	695,013	44,563	565,795	45,190
Netherlands	15,456	1,007	612,103	50,647	314,310	26,231
Switzerland	.....	.....	188,244	13,922	655,205	38,716
United Kingdom	1,165,608	100,882	4,644,792	333,060	2,419,240	198,482
Chile	.....	.....	11,141	607	126,256	7,242
All other	1,882	298	107,217	8,931	265,766	19,027
Total	6,550,197	727,850	22,714,877	1,805,543	8,705,147	824,136

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	44,713	$9,940	.....	.....	.....	.....
Belgium	12,540	2,552	.....	.....	.....	.....
France	380,912	36,606	444,327	$69,991	553,159	$90,929
Germany	1,041	96	.....	.....	.....	.....
Italy	215,540	15,850	1,003,708	123,122	140,905	15,032
Netherlands	163,669	13,162	113,170	30,405	121,253	41,761
Switzerland	851,043	49,291	77,161	5,781	25,647	5,227
United Kingdom	382,625	32,835	3,356,460	554,161	432,293	95,232
Chile	766,382	45,714	739,904	67,810	460,990	50,401
All other	190,020	10,987	530,867	76,720	314,296	49,659
Total	3,008,485	217,033	6,265,597	928,000	2,048,543	348,241

Glue and glue size—Imports by countries—Continued.

CALENDAR YEARS.

Imported from—	1918		1919		1920 [1]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	209,389	$41,903	160,072	$40,605	.....	.....
Netherlands	222,665	76,608	178,375	86,041	.....	.....
United Kingdom	132,584	34,992	142,669	23,237	.....	.....
Chile	89,589	9,631	250,183	24,411	.....	.....
Hongkong	185	121	881	407	.....	.....
Japan	35	9	495	80	.....	.....
Spain	15,873	4,364	220	71	.....	.....
Mexico	427	72	.....	.....	.....	.....
All other	.....	.....	133,147	34,030	.....	.....
Total	732,324	172,642	866,042	208,882	2,040,261	$523,096

[1] 10 months ended Oct. 31, 1920. Not stated by countries.

Imports for consumption—Glue and gelatin.

GLUE.

Fiscal year.	Grand total of all grades.				Valued not above 10 cents per pound.[1]				
	Pounds.	Value.	Revenue.	Equivalent ad valorem.	Pounds.	Value.	Per cent total quantity.	Average price.	Equivalent ad valorem.
				Per cent.					*Per cent.*
1910	6,415,265	$647,528	$188,395	29.1	5,947,184	$455,629	59.85	$0.076	32.68
1911	8,089,746	786,615	234,017	27.0	5,439,950	395,017	67.23	.073	34.43
1912	7,366,641	770,130	224,429	29.2	4,440,885	316,697	59.74	.071	35.06
1913	6,099,661	672,266	190,217	28.3	3,281,055	239,757	53.79	.073	34.21
4 years	27,971,313	2,876,539	837,058	29.1	19,069,074	1,406,500	60.64		
1914	937,263	97,861	27,555	28.1	450,203	32,670		.073	34.45
1914	21,564,205	1,693,244	251,146	14.8	18,835,736	1,280,462		.068	14.71
1915	8,086,283	702,350	100,852	14.3	6,435,337	459,637	79.58	.072	14.09
1916	3,030,573	218,084	34,014	15.6	2,713,554	173,039	89.87	.064	15.68
1917	6,292,311	954,017	154,083	16.1	978,167	81,228	15.39	.083	12.04
1918	2,013,312	342,017	60,319	17.6	383,115	36,392	19.03	.095	10.53
4 years	19,422,479	2,216,468	349,268	15.8	10,510,173	750,296	53.96		
1918 [2]	741,778	173,498	37,778	21.7	52,043	4,423	7.02	.084	11.77
1919 [2]	900,047	211,789	44,370	20.95	213,742	20,272	23.74	.094	10.54
1920 [2]	801,783	249,097	56,943	22.85	156,831	13,564	19.56	.086	11.56

[1] Glue size included 1914–17.

GELATIN.

1910	1,239,393	$389,307	$154,836	39.8	30,954	$2,210	2.51	$0.071	35.00
1911	1,327,970	393,164	154,148	39.2					
1912	701,508	135,556	39,984	29.5	441	37		.084	29.81
1913	1,085,940	278,892	100,242	35.8					
4 years	4,354,811	1,196,919	448,210	37.4	31,395	2,247	.71		
1914	236,970	71,938	27,044	37.5	45	3		.067	37.67
	2,202,470	696,277	149,501	21.5	17,726	1,324		.075	13.39

1915	2,708,362	916,368	194,200	21.2	485	37	.02	.076	13.11
1916	1,657,065	518,173	107,422	20.7	270	22	.02	.081	12.27
1917	967,920	309,524	73,836	23.8	1,830	72	.19	.039	25.41
1918	369,115	133,873	32,853	24.5					
4 years	5,702,462	1,877,938	408,311	21.7	2,585	131	.05		
1918 [3]	80,075	31,768	7,940	24.9					
1919 [3]	447,565	240,446	60,042	24.9					
1920 [3]	839,887	428,302	106,796	24.9					

[1] Prior to Oct. 4, 1913, the provision was "valued above 10 cents per pound, but not above 35 cents per pound," under the act of 1909.
[2] Prior to Oct. 4, 1913, the provision was "valued above 35 cents per pound," under the act of 1909.
[3] Calendar years 1918 and 1919, and 6 months ending June 30, 1920.

Imports for consumption—Glue and gelatin.

GLUE.

Fiscal year.	Valued above 10 cents but not above 25 cents per pound.[1]					Valued above 25 cents per pound.[2]				
	Pounds.	Value.	Per cent total quantity.	Average price.	Equivalent ad valorem.	Pounds.	Value.	Per cent total quantity.	Average price.	Equivalent ad valorem.
					Per cent.					*Per cent.*
1910	2,629,290	$386,960		$0.147	25.00	9,704	$4,921		$0.507	49.58
1911	2,648,780	390,925	32.74	.148	25.00	1,016	673	.03	.662	42.65
1912	2,965,315	453,079	40.25	.153	25.00	441	354	.01	.803	38.69
1913	2,817,981	431,913	46.20	.153	25.00	625	596	.01	.954	35.72
4 years	11,061,366	1,662,877				11,786	6,544	.02		
1914	487,038	65,177		.134	25.00	22	14		.64	43.47
1914	2,699,783	404,062		.15	15.00	28,686	8,720		.304	25.00
1915	1,649,127	241,798	20.39	.146	15.00	1,819	915	.03	.503	25.00
1916	332,721	44,536	10.98	.134	15.00	4,519	1,602	.15	.354	25.00
1917	4,904,216	739,649	77.94	.151	15.00	419,442	133,796	6.67	.319	25.00
1918	1,302,029	199,190	64.67	.153	15.00	328,168	106,435	16.30	.323	25.00
4 years	8,188,093	1,225,173	42.16			753,948	242,748	3.88		
1918[3]	334,296	50,112	45.07	.149	15.00	355,439	118,963	49.91	.334	25.00
1919[3]	378,432	56,464	42.05	.149	15.00	307,873	135,053	34.21	.438	25.00
1920[3]	274,664	36,083	34.26	.131	15.00	370,288	199,450	46.19	.538	25.00

GELATIN.

1910	744,857	$142,142	60.09	$0.191	25.00	463,582	$244,955	37.40	$0.530	48.39
1911	876,356	155,486	65.99	.178	25.00	451,614	237,678	34.01	.526	48.50
1912	651,479	107,382	92.87	.165	25.00	50,029	28,174	7.13	.563	46.64
1913	838,772	147,759	77.24	.176	25.00	247,168	131,133	22.76	.530	48.27
4 years	3,111,464	552,769	71.45			1,212,393	641,940	27.84		
1914	163,215	32,006		.196	25.00	73,710	39,929		.542	47.69
	1,312,861	244,140		.186	15.00	871,883	450,813		.517	25.00

1915	1,808,645	348,878	66.78	.193	15.00	899,232	567,453	33.20	.631	25.00
1916	1,006,518	221,191	60.74	.220	15.00	650,277	296,960	39.24	.457	25.00
1917	165,206	35,448	17.07	.215	15.00	800,884	274,004	82.74	.342	25.00
1918	30,226	6,147	8.19	.203	15.00	338,889	127,726	91.81	.377	25.00
4 years	3,010,595	611,664	52.79	.....	.....	2,689,282	1,266,143	47.16	.....	.....
1918 [3]	110	25	.12	.227	15.00	79,965	31,743	99.88	.396	25.00
1919 [3]	4,010	692	.89	.172	15.00	443,555	239,754	99.11	.545	25.00
1920 [3]	19,157	2,791	2.28	.145	15.00	820,730	425,511	97.72	.518	25.00

[1] Prior to Oct. 4, 1913, the provision was "valued above 10 cents per pound but not above 35 cents per pound," under the act of 1909.
[2] Prior to Oct. 4, 1913, the provision was "valued above 35 cents per pound," under the act of 1909.
[3] Calendar years 1918 and 1919, and 6 months ending June 30, 1920.

Isinglass and prepared fish sounds.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914[1]	25 per cent ad val.	85,896	$36,642	$9,160	$0.427	25
1915	do	11,906	9,008	2,252	.755	25
1916	do	13,750	14,498	3,624	1.050	25
1917	do	35,723	35,476	8,869	.995	25
1918	do	31,480	16,737	4,184	.530	25
1919	do	16,754	11,806	2,952	.705	25
Calendar years:						
1918	do	14,477	5,965	1,491	.404	25
1919	do	26,118	25,885	6,471	.991	25
1920[2]	do	22,178	20,797	5,199	.933	25

[1] From Oct. 4, 1913, to June 30, 1914. Not listed separately prior to this time.
[2] Six months ending June 30, 1920.

Agar-agar.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914[1]	20 per cent ad val.	189,199	$54,284	$10,856	$0.287	20
1915	do	344,119	92,809	18,561	.270	20
1916	do	332,931	110,410	22,082	.330	20
1917	do	431,622	162,527	32,505	.378	20
1918	do	246,988	91,442	18,288	.370	20
1919	do	338,307	172,832	34,566	.511	20
Calendar years:						
1918	do	261,594	109,457	21,891	.418	20
1919	do	483,397	264,923	52,985	.549	20
1920	do	180,578	101,690	20,338	.563	20

[1] From Oct. 4, 1913, to June 30, 1914. Not previously shown separately.

Glue—domestic exports.

FISCAL YEARS.

Exported to—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	129,698	$15,794	155,930	$17,916	92,134	$13,772
Germany	532,064	62,656	639,148	71,623	578,066	64,665
United Kingdom	1,014,250	96,675	870,586	81,504	1,141,028	111,415
Mexico	118,785	11,779	36,520	4,781	101,931	11,751
Cuba	107,997	11,459	94,432	10,773	157,013	16,581
Australia and Tasmania	63,278	6,219	64,837	6,482	86,908	8,668
Canada	328,027	36,547	252,083	25,514	519,766	50,149
All other	194,106	20,627	194,430	24,162	383,108	37,907
Total	2,488,205	261,756	2,307,966	242,755	3,059,952	314,909

Exported to—	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	124,539	$18,750	117,490	$15,350	44,197	$5,080
Germany	697,478	77,933	663,700	81,030	35,413	5,824
United Kingdom	447,334	50,710	583,915	59,170	1,145,550	117,970
Mexico	95,806	11,006	35,618	4,642	64,979	7,560
Australia and Tasmania[1]	81,454	8,673	87,183	9,227	96,399	10,574
Canada	624,312	61,565	367,267	39,009	641,298	64,342
All other	474,019	47,982	496,600	59,183	846,389	86,786
Total	2,544,942	276,619	2,351,773	258,611	2,874,225	298,136

[1] Australia alone beginning with 1914.

Glue—domestic exports—Continued.

FISCAL YEARS—Continued.

Exported to—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	71,816	$10,434	145,615	$16,706	23,199	$4,142
United Kingdom	1,703,879	187,707	647,991	78,740	789,585	78,470
Mexico	62,706	8,225	90,133	21,265	86,723	26,568
Australia	149,358	20,632	64,619	11,294	85,673	20,838
Canada	1,053,156	85,176	1,620,642	143,825	1,830,349	214,212
Cuba	352,590	40,427	308,166	50,216	696,426	149,431
China	241,925	24,341	151,482	19,498	405,844	100,202
Japan	631,900	78,472	131,660	18,910	314,134	78,309
All other	678,898	75,915	903,923	153,321	669,831	165,507
Total	4,946,228	531,329	4,064,231	513,775	4,901,764	837,679

CALENDAR YEARS.

Exported to—	1918		1919		1920 [1]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Denmark	35,997	$11,638	508,641	$108,406	.....	.....
France	31,757	4,853	180,564	40,116	.....	.....
Netherlands	.....	.....	241,958	34,962	.....	.....
England	717,053	68,854	1,521,221	239,616	.....	.....
Canada	1,508,229	215,189	2,528,447	278,125	.....	.....
Mexico	73,197	22,568	137,586	35,009	.....	.....
Labrador and Newfoundland	55,131	7,704	39,311	5,736	.....	.....
Cuba	608,714	127,620	517,197	102,188	.....	.....
Argentina	56,241	15,225	76,816	15,154	.....	.....
Brazil	53,261	14,349	21,013	6,747	.....	.....
Peru	25,550	7,865	27,018	8,412	.....	.....
China	472,507	108,352	727,678	169,407	.....	.....
Kwantung, leased territory	28,064	7,435	117,796	18,348	.....	.....
Dutch East Indies	248,380	49,722	276,359	54,728	.....	.....
Japan	1,127,065	254,051	575,588	135,817	.....	.....
Australia	99,101	21,494	115,309	27,801	.....	.....
Philippine Islands	145,006	33,798	205,218	42,853	.....	.....
British South Africa	278,696	72,637	32,823	7,159	.....	.....
All other	245,656	68,483	635,624	149,193	.....	.....
Total	5,809,605	1,110,837	8,486,167	1,480,777	12,449,799	$2,159,094

[1] 10 months ending Oct. 31, 1920.

Glue—Prices (wholesale), spot, New York market.

[From Oil, Paint, and Drug Reporter.]

[Cents per pound.]

	1912	1913	1914	1915	1916	1917	1918	1919
Extra white:								
January	18–24	18–24	18–24	18–24	18–24	25–33	35–45	36–45
April	18–24	18–24	18–24	18–24	18–24	25–33	35–45	36–45
July	18–24	18–24	18–24	18–24	18–24	25–33	36–45	35–40
October	18–24	18–24	18–24	18–24	18–24	33–35	36–45	35–40
Medium white:								
January	.....	12–18	12–18	12–18	12–18	22–23	30–35	31–35
April	.....	12–18	12–18	12–18	12–18	22–23	30–35	31–35
July	.....	12–18	12–18	12–18	16–17	22–23	31–35	30–35
October	.....	12–18	12–18	12–18	16–17	30–35	31–35	30–35
Cabinet:								
January	13–15	13–15	13–15	13–15	13–15	19–20	30–40	28–40
April	13–15	13–15	13–15	13–15	13–15	19–20	30–40	26–38
July	13–15	13–15	13–15	13–15	13–15	19–25	31–40	25–36
October	13–15	13–15	13–15	13–15	13–15	30–40	31–40	25–36

Glue—Prices (wholesale), spot, New York market—Continued.

[Cents per pound.]

	1912	1913	1914	1915	1916	1917	1918	1919
Low grade:								
January	10-12	10-12	10-12	10-12	10-12	20-21	26-28	22-26
April	10-12	10-12	10-12	10-12	10-12	20-21	23-27	20-25
July	10-12	10-12	10-12	10-12	10-15	20-21	24-27	20-25
October	10-12	10-12	10-12	10-12	14-15	25-28	24-27	20-25
Foot stock, white:								
January	12 -14	12 -14	12 -14	12 -14	12 -14	18-19	22-24	15-20
April	12 -14	12 -14	12- 14	12 -14	12 -14	18-19	18-24	14-18
July	12 -14	12 -14	12 -14	12 -14	12 -14	18-24	16-22	13-18
October	12 -14	12 -14	12 -14	12 -14	12 -14	22-24	16-22	13-18
Foot stock, brown:								
January	9 -11	9 -11	9 -11	9 -11	9 -11	15-17	20-25	16-20
April	9 -11	9 -11	9 -11	9 -11	9 -11	15-17	20-25	15-19
July	9 -11	9 -11	9 -11	9 -11	9 -11	15-17	18-22	12-16
October	9 -11	9 -11	9 -11	9 -11	9 -11	20-25	18-22	12-16
Common bone:								
January	7½- 9	7½- 9	7½- 9	7½- 9	7½- 9	16-20	18-22	14-18
April	7½- 9	7½- 9	7½- 9	7½- 9	7½- 9	16-20	15-22	13-17
July	7½- 9	7½- 9	7½- 9	7½- 9	10 -14	16-20	15-20	10-15
October	7½- 9	7½- 9	7½- 9	7½- 9	10 -14	20-23	15-20	11-15
Irish:								
January	12½-12½	12½-12½	12½-12½	13 -15	13 -15	21-23	(1)	(1)
April	12½-12½	13 -15	12½-12½	13 -15	13 -15	21-23	(1)	(1)
July	12½-12½	13 -15	12½-12½	13 -15	15 -17	21-23	(1)	(1)
October	12½-12½	13 -15	12½-12½	13 -15	15 -17	(1)	(1)	(1)
French:								
January	10 -40	10 -40	10 -40	10 -40	10 -40	26-50	(1)	(1)
April	10 -40	10 -40	10 -40	10 -40	10 -40	26-50	(1)	(1)
July	10 -40	10 -40	10 -40	10 -40	20 -50	26-50	(1)	(1)
October	10 -40	10 -40	10 -40	10 -40	20 -50	(1)	(1)	(1)
Fish liquid (50-gallon barrels):	*Per gallon.*	*Per gallon.*	*Per gallon.*	*Per gallon.*	*Per gallon.*	*Per gallon.*	*Per gallon.*	*Per gallon.*
January	$0.60-1.20	$0.70-1.40	$0.70-1.40	$0.70-1.40	$0.70-1.40	$0.80-1.40	$1.00-1.80	$1.00-1.80
April	.60-1.20	.70-1.40	.70-1.40	.70-1.40	.70-1.40	.80-1.40	1.00-1.80	1.00-1.80
July	.60-1.20	.70-1.40	.70-1.40	.70-1.40	.80-1.40	.80-1.40	1.00-1.80	1.00-1.80
October	.60-1.20	.70-1.40	.70-1.40	.70-1.40	.80-1.40	1.00-1.80	1.00-1.80	1.00-1.80

[1] Nominal.

Glue—Prices (wholesale), spot, New York market, 1920.

[From Oil, Paint, and Drug Reporter.]
[cents per pound.]

	Extra white.	Medium white.	Cabinet.	Low grade.	Foot stock, white.	Foot stock, brown.	Common bone.	Irish.
January, 1920	35-40	30-35	25-36	20-25	13-18	12-16	11-15	(1)
April	35-40	30-35	25-36	20-25	13-18	12-16	11-15	(1)
July	35-40	30-35	25-36	22-26	19-22	19-22	18-21	(1)
October	35-45	30-35	25-36	22-26	19-22	19-22	18-21	(1)

[1] Nominal.

Gelatin—Prices (wholesale), spot, New York market, cents per pound.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919
Gelatin, gold:								
January	30-50	35-37	35-37	40-42	75- 80	90-100	68	(1)
April	30-50	35-37	35-37	40-42	75- 80	(1)	(1)	(1)
July	30-50	35-37	35-37	40-42	90-100	.....	(1)	(1)
October	35-37	35-37	40-42	50-60	90-100	69- 70	(1)	(1)
Gelatin, silver:								
January	22-25	26-27	26-27	35-40	60- 65	115-125	145-150	125-130
April	22-25	26-27	26-27	35-40	60- 65	110-120	(1)	115-120
July	24-25	26-27	26-29	45-50	85- 90	140-145	145-150	100-115
October	25-26	26-27	30-32	50	100	160-170	145-150	100-115

[1] Nominal.

Isinglass—Prices (wholesale) spot, New York market, per pound.

[Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919
Russian:								
January	$2.50–2.75	$3.00–3.25	$3.25–3.50	$4.50–5.00	$7.50–8.00	$4.75–5.00	$4.00	$9.00–9.25
April	2.35–2.50	3.50	3.25–3.50	5.25–5.50	7.50–8.00	4.00–4.25	$4.50–5.00	(1)
July	3.00–3.25	3.25–3.50	3.50–3.75	5.50–5.75	5.50–6.00	4.00	7.00–7.10	10.00–11.00
October	2.85–3.00	3.25–3.50	4.50–5.00	7.50–8.00	5.25–5.50	4.00	7.50–8.00	10.00–11.00
American:								
January	.65–.70	.62–.65	.71–.76	.80–1.00	.75–.80	.75–.80	.80	
April	.65–.70	.65–.70	.71–.76	.80–1.00	.75–.80	.75–.80	.80	
July	.62–.65	.65–.70	.71–.76	.78–.80	.75–.80	.80		
October	.62–.65	.71–.76	.80–.85	.75–.80	.75–.80	.80		

[1] Nominal.

Agar-agar—Prices (wholesale) spot, New York market, cents per pound.

[Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919
No. 1:[1]								
January	48–55	37–65	41–60	37½–52	43–58	53–55	56–58	90–95
April	42–50	37–65	41–62	37½–52	43–58	58–59	62–63	90–95
July	38–65	37–65	37–50	35–60	(2)	61–62	85–86	78–80
October	37–65	37–65	48–65	33–50	54–58	64–66	85–86	85–86

[1] Prior to 1914 listed as Japanese isinglass. [2] Not quoted.

Glue, gelatin, isinglass, and agar-agar—Prices (wholesale) spot, New York market, per pound.

[Oil, Paint, and Drug Reporter.]

	Glue.		Gelatin.		Isinglass.		Agar-agar, No. 1.
	French	Fish, liquid.[1]	Gold.	Silver.	American.	Russian.	
January, 1920	(2)	$1.25–1.80	$1.20–1.25	(2)	(2)	$10.00–11.00	$0.85–0.86
April, 1920	(2)	1.25–1.80	1.25–1.50	(2)	(2)	10.00–11.00	.79–.80
July, 1920	(2)	1.40–1.80	1.75–2.00	(2)	(2)	10.00–11.00	.60–.61
October, 1920	(2)	1.40–1.80	(2)	$1.75–2.00	(2)	10.00–11.00	.60–.61

[1] In 50-gallon barrels, per gallon. [2] Nominal. [3] No quotations.

Gelatin—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1883	1	Glue	20 per cent ad valorem.
	3	Gelatin, and all similar preparations	30 per cent ad valorem.
	6	Fish glue or isinglass	25 per cent ad valorem.
	515	Fish sounds or fish bladders	Free.
1890	27	Gelatin, glue, and isinglass or fish glue, valued at not above 7 cents per pound.	1½ cents per pound.
		Valued at above 7 cents per pound and not above 30 cents per pound.	25 per cent ad valorem.
		Valued at above 30 cents per pound	30 per cent ad valorem.

Gelatin—Rates of duty—Continued.

Act of—	Par.	Tariff classification or description.	Rate of duty, specific and ad valorem.
1894	19	Gelatin, glue, isinglass or fish glue, and prepared fish bladders or fish sounds.	25 per cent ad valorem.
	354	Manufactures of * * * gelatin * * * or of which these substances or either of them is the component material of chief value, not specially provided for in this act.	35 per cent ad valorem.
1897	23	Gelatin, glue, isinglass, or fish glue, and prepared fish bladders or fish sounds, valued at not above 10 cents per pound.	2½ cents per pound.
		Valued at above 10 cents per pound and not above 35 cents per pound.	25 per cent ad valorem.
		Valued above 35 cents per pound	15 cents per pound. and 20 per cent ad valorem.
	450	Manufactures of * * * gelatin, * * * or of which these substances or either of them is the component material of chief value, not specially provided for in this act, * * *.	35 per cent ad valorem.
1909	23	Gelatin, glue, isinglass or fish glue, including agar-agar or Japanese isinglass, and all fish bladders and fish sounds other than crude or dried or salted for preservation only, valued at not above 10 cents per pound.	2½ cents per pound.
		Valued at above 10 cents per pound and not above 35 cents per pound.	25 per cent ad valorem.
		Valued above 35 cents per pound	15 cents per pound and 20 per cent ad valorem.
		Gelatin in sheets, emulsions, and all manufactures of gelatin, or of which gelatin is the component material of chief value, not specially provided for in this section.	35 per cent ad valorem.
		Glue size	25 per cent ad valorem.
1913	34	Gelatin, glue, and glue size, valued not above 10 cents per pound	1 cent per pound.
		Valued above 10 cents per pound and not above 25 cents per pound.	15 per cent ad valorem.
		Valued above 25 cents per pound	25 per cent ad valorem.
		Manufactures of gelatin or manufactures of which gelatin is the component material of chief value.	Do.
		Isinglass and prepared fish sounds	Do.
		Agar-agar	20 per cent ad valorem.

Court and Treasury Decisions.

Tuberine, said in 1902 to be a new form of glue and classified by the collector as a preparation fit for use as starch (G. A. 5093, T. D. 23561), and bitocol, made from bones or from other animal substances and chemicals (Abstract 40424, of 1916), were held to be dutiable as glue. "Sichel glue," a proprietary preparation of dextrin, flour starch, vegetable gum, and water, used chiefly for sizing walls and as a binder in the use of calcimine (G. A. 6206, T. D. 26854, of 1905) and bone size, used for filling and softening corduroys (Sheldon *v.* United States, 127 Fed., 494, of 1903), were held dutiable as unenumerated manufactured articles and not as glue directly or by similitude.

The provision for glue in the act of 1894 (par. 19) was declared by the Board of General Appraisers to be limited to animal substances and not to include marine glue, which was described as a mixture of naphtha (or coal tar), shellac, and india rubber or as a mixture of resin or Burgundy pitch with india rubber and a little shellac (G. A. 3101, T. D. 16222, of 1895).

Gelatin in thin pieces practically transparent, about 8 inches long and 3 inches wide, with irregular edges and dented surfaces, declared to be, according to the record, the highest priced edible gelatin on the market, was held to be gelatin and not gelatin in sheets under

the act of 1909 (American Express Co. *v.* United States, 3 Ct. Cust. Appls., 475, of 1913).

A physical (not a chemical) solution of gelatin with acetic acid, water, and coloring matter, the gelatin being the component material of chief value, and still possessing its natural inherent qualities, known as "Red Top roller varnish" or "roller varnish," used in woolen mills to dress the surface of leather rollers to keep the wool from sticking, was held dutiable as a manufacture of gelatin rather than as a varnish under paragraph 34 of the act of 1913 (United States *v.* Vandegrift, 9 Ct. Cust. Appls., 30, of 1918).

Merchandise variously described as cellophane, flexoloid, dramantine, and brilliantine, used as a substitute for thin gelatin sheets in wrapping candy and candy boxes, and to some extent as the transparent part of patent envelopes, classified by similitude as a manufacture of gelatin under the act of 1913, was held dutiable as an unenumerated manufactured article (Abstracts 37423, 38805, 39525) under the acts of 1909 and 1913.

So-called "liquid albumen," made from the albuminous or gelatinous portion of fish with a small quantity of sulphuric acid added as a preservative, and used for clarifying wine and other purposes for which albumen is used, was classified as gelatin and not as a manufacture of gelatin under the act of 1897 (Sonoma Wine & Brandy Co. *v.* United States, 123 Fed., 999, of 1900).

Merchandise described as agar-agar, or Japanese isinglass, manufactured from a seaweed by processes of boiling, filtering, freezing, etc., whereby it lost its fibrous qualities and became soluble in water and which in its use, and somewhat in its material and texture, resembled the isinglass of commerce, was held dutiable by similitude at the rates applicable to "isinglass or fish glue" in paragraph 23 of the act of 1897 (G. A. 5228, T. D. 24053, of 1897).

The spine of the sturgeon, said to be "eaten as a Russian food like macaroni," was likewise classified under paragraph 23 of that act rather than as dried fish under paragraph 273 (Abstract 37352).

Fish sounds, split, washed, and dried in the sun, such splitting being part of the drying process, were held not "prepared fish sounds" within this paragraph, but exempt from duty under the provisions in paragraph 419 for "fish sounds, crude, dried, or salted for preservation only, and unmanufactured," the cleaning, drying, and splitting for cleansing or drying being declared not processes of manufacture (United States *v.* Brown & Co., 10 Ct. Cust. Appls., —; T. D. 38295, of 1920).

GLYCERIN.

[Par. 35, act of 1913.]

SUMMARY.

Description.—Glycerin is a heavy, sweet, sirupy liquid. The impure grades are straw colored while the pure product is colorless. There are several grades in commerce, C. P. glycerin; dynamite glycerin; 30°, yellow, distilled; soap lye loose, and saponification loose.

The largest use for glycerin is in the manufacture of nitroglycerin which is used in the manufacture of dynamite. It has many other uses in the arts. It is used as a solvent, preservative, medicinal, and as a sweetening agent.

Domestic production.—The production of refined glycerin in 1914 amounted to 60,944,799 pounds. Of this quantity there were sold 59,810,405 pounds, valued at $10,779,204, the remainder was consumed in the plants where made.

The production of crude glycerin in the United States is less than one-half of the output of refined glycerin. In 1914 there were imported 36,230,392 pounds of crude glycerin, while 16,568,920 pounds were reported as being sold in the United States (domestic manufacture), making a total consumption of about 53,000,000 pounds. This quantity is 17,000,000 pounds less than the reported production of refined glycerin. This discrepancy is undoubtedly due to the fact that certain domestic soap companies also operated refineries and therefore the crude glycerin which was refined by these firms was not sold or reported. The total production of crude glycerin in this country might be estimated then at about 33,000,000 pounds.

Glycerin is obtained exclusively as a by-product of the soap, candle, and stearic-acid industries. The fats and fatty oils, raw materials in these industries, contain glycerin in chemical combination with the various fatty acids.

Glycerin is purified by vacuum distillation. There are a number of special kinds of apparatus which have been patented. Efficient operation in glycerin refining is dependent upon the individual skill and care of the operator.

Crude glycerin is produced by practically all of the soap manufacturers. Only the large firms, however, operate refining plants. The industry is a large one and is rather widely distributed.

No domestic exports of glycerin are shown in Commerce and Navigation.

Foreign production.—The world's output of crude glycerin has been estimated at about 85,000 tons per year and the consumption in the United States at 40,000 tons, or about one-half of the total.

NOTE.—On p. 8 of W. I. B. price bulletin No. 49. Prices of soaps and glycerin, the 1917 production of glycerin is given as 70,000,000 pounds.

In England and France the normal demands for soap result in more of the by-product glycerin than can be utilized. The United States, on the other hand, is a newer and larger country and construction work requiring large quantities of nitroglycerin is continually underway.

Imports.—The normal prewar imports of crude glycerin amounted to between 30 and 40 million pounds annually. Over 50 per cent of the imports originate in England and France. Since the beginning of the war the imports of crude glycerin have decreased to about 4,000,000 pounds in 1917, when no imports were received from France or England, owing to the military demand.

The imports of refined glycerin have been very small; since 1910 they have been less than 500,000 pounds. The import duty was collected on only a very small portion of this quantity, owing to the duty being remitted under the provisions of section 23 of the act of 1909.

Imports of crude glycerin are supplementary to the domestic production.

Prices.—The prewar prices of the various grades of glycerin have about tripled since the outbreak of the war.

Tariff history.—Crude glycerin was dutiable at 1¾ cents per pound by the act of 1890. This duty was reduced by the act of 1894 to 1 cent per pound, which has been in force since that time.

Refined glycerin was dutiable at 4½ cents per pound by the act of 1890. The acts of 1894, 1897, and 1909 specified a duty of 3 cents per pound. This was reduced to 2 cents per pound by the act of 1913.

Glycerin, crude, not purified—Summary table.

	Domestic production.	Imports for consumption.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
Fiscal year:	*Pounds.*	*Pounds.*				*Per cent.*
1910		41,024,712	$3,635,005	$409,975	$0.090	11.25
1911		40,192,804	4,339,299	401,657	.108	9.29
1912		29,983,743	3,681,168	299,338	.123	8.12
1913		34,399,129	4,247,032	343,479	.124	8.04
1914	[1]16,568,920	36,230,392	4,473,178	361,859	.124	8.05
1915		18,661,929	2,185,368	186,002	.117	8.50
1916		10,875,058	2,209,610	108,115	.204	4.90
1917		4,078,803	1,260,454	39,892	.310	3.17
1918		1,925,815	820,245	17,905	.425	2.18
1919		1,163,952	368,680	11,134	.317	3.02
Calendar year:						
1918		1,472,269	629,436	13,952	.452	2.21
1919		3,813,630	444,797	37,637	.113	8.65
1920[1]		12,412,504	1,515,857	124,113	.122	8.12

[1] Figures not available for total production of crude glycerin for 1914, as that made and consumed in the manufacture of a large portion of the refined glycerin was not reported.

No expert statistics are published in Commerce and Navigation, but it is believed that they are of little significance.

Glycerin, refined—Summary table.

	Domestic production.	Imports for consumption.	Ratio to production—Imports.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
Fiscal year:	*Pounds.*	*Pounds.*	*Per cent.*				*Per cent.*
1910		244,098		$39,066	[1]		
1911		231,236		47,378			
1912		183,893		36,220			
1913		432,339		73,336			
1914	60,944,799	336,988	0.55	58,506	$6,765	$0.174	11.58
1915		208,260		37,917	4,165	.181	10.99
1916		303,463		132,469	6,069	.437	4.58
1917		137,128		76,361	2,743	.555	3.59
1918		19,750		17,438	395	.883	2.27
1919		162,916		67,597	3,259	.415	4.82
Calendar year:							
1918		137,826		78,467	2,757	.569	3.51
1919		39,059		4,471	781	.114	17.47
1920		1,911,237		414,300	38,224	.216	9.22

[1] Duty remitted on part of the imports from 1910–1913 under section 23 of the act of 1909.

General Information.

Nomenclature.—Glycerin is known in the scientific nomenclature as glycerol, since its chemical structure is that of an alcohol. Other chemical designations by which it is sometimes called are glycyl alcohol, propenyl alcohol, and propanetriol. The commercial name, glycerin, still obtains in common usage and its use in the tariff law seems advisable.

Description of grades.—The tariff classification recognizes but two grades of glycerin, namely, the crude and unpurified glycerin and the refined glycerin. In commerce, however, there are several divisions of each of these grades. According to the process by which the product is obtained, it is customary to differentiate the following grades of crude glycerin: (1) Soap-lye crude glycerin, (2) crude saponification glycerin, (3) crude distillation glycerin, (4) Twitchell crude glycerin, and (5) fermentation crude glycerin. The first two grades are of most importance in commerce.

Soap-lye crude glycerin or soap crude glycerin is the principal source of supply. It is obtained in the saponification of fats by caustic soda after the soap has been thrown out of solution by the addition of salt. The mother liquor or spent lye contains 4 to 5 per cent of glycerin together with the impurities from the fat and the excess of salt. The organic impurities are precipitated and after filter pressing the dilute glycerin is concentrated in vacuum evaporators. The crude soap glycerin when cold has a specific gravity of 1.30°, or 33.5° Baumé. The glycerol content is about 80 per cent, although it may vary from 60 per cent in the poorer grades to 87 per cent in the highly concentrated crudes of best quality. Crude soap-lye glycerin is usually recognized by its high content of salt.

Crude saponification glycerin represents the best quality of crude glycerin. It is obtained from the "sweet waters" of the autoclave process of saponification and from the lime and soda process of making soap. This latter process consists in hydrolyzing the fats with lime water and decomposing the resulting lime soaps with sulphuric acid. The fatty acids are converted to soap with soda. The process is limited to only the smaller soap producers. Crude saponification glycerin when concentrated contains about 85 to 90 per cent of glycerol and has a specific gravity of 1.240° to 1.242°, or 28° Baumé.

Refined glycerin is somewhat more limited in its scope and usually includes only two kinds of distilled glycerin:

Dynamite glycerin is glycerin in its highest concentration. It has a slightly yellow color although otherwise it is very pure and is suitable for the manufacture of nitroglycerin for dynamite.

Chemically pure glycerin is glycerin that has been given especial purification by repeated distillations. For this reason it is sometimes known as "twice or treble distilled glycerin." It is a very sweet, colorless, sirupy liquid.

Source of glycerin.—Animal fats and vegetable fatty oils (such as tallow, cottonseed oil, olive oil, palm oil, etc.), all contain glycerin chemically combined with various fatty acids. Glycerin is obtained commercially exclusively as a by-product of the soap, candle, and stearic-acid industries. In the soap industry fats and fatty oils are decomposed by alkalies to yield soap and a dilute and impure lye containing glycerin, together with a large excess of salt with much

organic impurity. These spent lyes are the principal source of glycerin. (See above under soap-lye crude glycerin.)

Fats are also decomposed commercially by other processes such as treatment with steam under pressure (the autoclave process), or by steam in the presence of small amounts of acid (the acid saponification process), or of small amounts of Twitchell's reagent (the Twitchell process), or by fermentation. The Krebitz process consists in decomposing the fat in the presence of sufficient lime water to combine with the fatty acid and form the insoluble calcium or lime soap. This is then removed from the glycerin solution by filtering and is again decomposed by acid if it is wished to recover the fatty acids or by an alkali if soap is desired. These processes, however, are of rather minor importance, although all of them yield glycerin as a by-product.

Purification of glycerin.—All of the larger soap and candle-making establishments concentrate and refine their glycerin lyes, although the smaller concerns merely concentrate and then sell the crude glycerin to the glycerin refiners. These refiners also import large amounts of crude glycerin which is purified and sold to the American consumers.

The only method used for the purification of glycerin is distillation—and this requires skilled and careful control, since glycerin decomposes at the temperature of boiling under atmospheric pressure, and since many of the impurities such as the organic acids are volatile. Pure glycerin boils with considerable decomposition at 290° C., but if the pressure is reduced to 50 mm., the boiling point is lowered to 210°, and a further reduction of the pressure to 12.5 mm. results in a boiling point of 180° C.

The distillation is carried out in vacuo and with the aid of superheated steam. There are a number of forms of special apparatus which have been patented, and for which improvements are continually being made, but the fact remains that the efficient operation depends not so much on the kind of still and condenser as upon the individual skill and care of the operator. The details of operation and the pressures maintained are usually regarded as trade secrets. A single distillation, however, yields a product which on evaporation can be used for making dynamite. It has a pale straw color, but as far as the tariff is concerned it is regarded as refined glycerin. The chemically pure grades of glycerin are obtained from the above by repeated distillation.

Uses for glycerin.—The largest use for glycerin is in the manufacture of nitroglycerin for the useful explosive, dynamite. Nitroglycerin (chemically glyceryl trinitrate) is prepared by running glycerin slowly into a mixture of sulphuric acid and nitric acid. It is a light-yellow liquid which explodes upon concussion. Dynamite is prepared by mixing nitroglycerin with infusorial earth, sawdust, or some similar inert material. The most powerful grades contain 75 per cent of nitroglycerin. Explosive gelatin is a mixture of 93 per cent of nitroglycerin and 7 per cent of nitrocellulose.

The other uses for glycerin are numerous. It is used in cosmetics, drugs, and medicines, in printing and dyeing of textiles, in finishing leather, in making printer's rollers, rubber-stamp ink, and ink pads. It is used as a means of preserving tobacco, since it has the advantage

of imparting a sweet taste to the product. Many fermented drinks contain glycerin as a sweetening agent.

These and other uses for glycerin take advantage of the following properties of glycerin:

Antifreezing: Example—automobile-radiator preparations, gas meters, hydraulic jacks.

Solvent: Example—application of some coal-tar dyes to fabrics, extraction of perfume substances from flowers.

Preservative: Example—food and tobacco preservation, "glycerizing" of cork stoppers to prevent the growth of molds.

Medicinal: Example—a constituent of certain medicinals, e. g., glycerophosphates, glycerites of various metals; a vehicle for applying various substances to the skin for absorption.

Sweetening: Example—beverages and confections.

Competitive conditions.—Glycerin is exclusively a by-product of the soap, candle, and stearic-acid industries, and the output depends not so much on the demand for glycerin as for the world's requirements of soap and candles. The world's output of crude glycerin has been estimated at about 85,000 tons per year and the consumption in the United States at 40,000 tons per year. The United States does not produce sufficient glycerin to meet its own requirements and before the war imported thirty to forty million pounds of foreign crude glycerin. The bulk of this came from England and France. In these countries the normal demands for soap result in more of the by-product, glycerin, than can be utilized. The United States, on the other hand, is a newer and larger country and construction work requiring large amounts of dynamite and nitroglycerin is continually under way. The interesting relation thus existing between soap and dynamite, though not particularly obvious to the layman, is clearly reflected in the international trade of glycerin.

Since the beginning of the war, the imports into the United States have dropped off very greatly, decreasing from 36,000,000 pounds in 1914 to 18,000,000 pounds in 1915. In 1917 the imports had further decreased to slightly over 4,000,000 pounds and of this amount none came from England. The explanation of this, of course, is the direct war demand for nitroglycerin for the manufacture of the English military explosive, cordite.

With the increasing use of high-grade fats for butter substitutes and the conversion of the fatty oils to hard edible fats, the soap and candle makers are compelled to use fats and oils of a poorer quality than formerly used. These fats are high in the free fatty acids and low in glycerin, so that there is a tendency at present toward a lowering of the proportion of glycerin to soap. The present high prices, however, have encouraged the most efficient improvements in the methods of recovery, so that any decrease due to the use of poorer grades of fats is probably more than counterbalanced.

Domestic production.—The following table of production of glycerin was taken from the Abstract of the Census of Manufactures, 1914:

Production of glycerin in United States.[1]

	1914	1909	1904	1899
Glycerin:[2]				
Crude, for sale—				
Pounds	16,568,920			
Value	$2,278,976			
Refined.....pounds..	60,944,799	79,677,490	46,972,658	26,512,454
For sale—		$11,752,580	$5,355,320	$3,096,601
Pounds	59,810,405			
Value	$10,779,204			
Made, consumed.....pounds..	1,134,394	.....	.....	.....

[1] From Census of Manufactures, 1914.
[2] Figures not available for total production of crude glycerin, 1914, as that made and consumed in the manufacture of a large portion of the refined glycerin was not reported.

Glycerin produced for sale, crude and refined—Production in United States—States and cities.

States or cities.	1899		1904		1909	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
California	.....	.....	.....	.....	749,685	$61,331
Illinois	.....	.....	.....	.....	13,767,008	1,858,329
Massachusetts	.....	.....	.....	.....	1,143,760	144,112
Missouri	.....	.....	.....	.....	1,997,790	188,734
New Jersey	.....	.....	.....	.....	4,947,695	653,295
New York	.....	.....	.....	.....	27,785,268	3,979,485
Ohio	.....	.....	.....	.....	17,185,148	2,891,709
Pennsylvania	.....	.....	.....	.....	1,967,823	256,460
All other	.....	.....	.....	.....	12,341,359	1,719,107
Total	26,512,454	$3,096,601	46,972,658	$5,355,320	[1]81,885,536	11,752,562

States or cities.	1914		States or cities.	1914	
	Quantity.	Value.		Quantity.	Value.
	Pounds.			*Pounds.*	
California	1,067,965	$150,158	New York	28,397,071	$5,224,899
Illinois	12,219,029	2,172,749	Ohio	14,852,484	2,747,217
Kansas	5,557,022	1,056,768	All other	11,845,177	1,305,621
Massachusetts	1,270,030	196,298			
Missouri	1,170,547	204,470	Total	76,379,325	13,058,180

[1] In addition, 5,633,197 pounds were reported without value and 5,879,279 pounds as used in establishments where produced, or a total production of 93,398,012 pounds.

Glycerin, crude—Imports by countries.

FISCAL YEARS.

Imported from—	1910		1911	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Austria-Hungary	613,754	$59,079	197,885	$17,159
Belgium	3,670,617	353,578	3,245,435	418,330
France	15,943,692	1,341,844	13,620,247	1,386,335
Germany	859,992	98,657	530,337	63,832
Italy	2,213,472	210,856	2,019,702	218,944
Netherlands	2,282,706	203,143	2,607,142	327,448
Russia, European	244,236	15,454	627,622	79,098
Spain	563,072	71,749	946,944	157,348
England	12,996,366	1,143,873	14,708,730	1,507,525
Canada	1,026,247	103,078	834,747	104,972
Mexico	530,912	42,074	483,497	51,994
All other	236,400	22,378	286,719	36,434
Total	41,181,526	3,665,763	40,109,007	4,364,419

Glycerin, crude—Imports by countries—Continued.

FISCAL YEARS—Continued.

Imported from—	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Austria-Hungary	317,013	$49,543	702,081	$111,269	256,151	$30,959
Belgium	2,119,804	306,270	4,047,395	527,994	2,672,405	350,211
France	7,986,295	910,880	9,442,429	1,078,344	11,204,503	1,326,885
Germany	1,741,032	224,858	1,895,070	244,644	1,881,779	241,583
Italy	1,586,579	215,430	1,422,045	195,863	859,202	109,855
Netherlands	1,613,100	209,533	1,674,031	211,672	2,566,056	308,413
Russia, European	750,809	102,996	1,574,961	223,705	1,959,298	240,263
Spain	147,189	18,685	1,525,585	171,741	1,664,782	210,557
England	12,063,245	1,444,222	10,206,780	1,279,501	10,466,023	1,312,978
Canada	592,579	69,939	1,043,228	116,345	1,324,594	156,228
Mexico	695,818	80,925	447,842	38,157	541,054	63,987
Argentina	.....	.....	.....	.....	291,038	39,811
All other	319,857	41,645	432,330	52,606	722,734	94,685
Total	29,933,320	3,674,926	34,413,507	4,251,841	36,409,619	4,486,415

Imported from—	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Austria-Hungary	117,726	$11,216	.....	.....	.....	.....
Belgium	507,017	68,199	.....	.....	.....	.....
France	3,961,393	489,004	1,754,537	$223,459	.....	.....
Germany	44,808	5,473	.....	.....	.....	.....
Italy	159,029	21,083	.....	.....	.....	.....
Netherlands	789,377	90,075	898,855	234,348	499,124	$114,099
Russia, European	623,675	81,294	.....	.....	.....	.....
Spain	157,672	19,254	2,553,486	689,610	792,555	282,506
England	7,820,542	962,782	858,854	107,378	.....	.....
Canada	1,436,209	196,615	845,822	108,690	34,661	2,679
Mexico	1,157,998	130,608	531,055	139,287	305,780	86,459
Argentina	66,535	9,054	1,088,737	208,204	907,491	289,476
Brazil	348,091	48,241	941,990	276,394	800,202	292,597
All other	430,437	53,857	1,148,067	245,124	782,597	229,343
Total	17,620,509	2,186,755	10,621,403	2,232,494	4,122,410	1,297,159

Imported from—	1918	
	Quantity.	Value.
	Pounds.	
Mexico	204,192	$81,212
Cuba	428,495	195,591
Argentina	507,303	204,361
Brazil	644,290	296,785
All other	91,151	26,069
Total	1,875,531	804,018

CALENDAR YEARS.

Imported from—	1918		1919		1920 [1]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	.....	.....	1,806,521	$177,033	.....	.....
England	.....	.....	360,078	41,434	.....	.....
Canada	13,569	$7,144	490,882	58,840	.....	.....
Mexico	161,468	57,124	2,866	325	.....	.....
Cuba	470,266	197,466	306,371	33,409	.....	.....
Argentina	257,878	118,781	.....	.....	.....	.....
Brazil	465,232	214,067	316,264	74,164	.....	.....
Japan	42,520	14,284	.....	.....	.....	.....
All other	33,944	10,665	530,648	62,767	.....	.....
Total	1,444,847	618,531	3,813,630	447,972	20,863,078	$2,706,107

[1] Ten months ending Oct. 31, 1920.

Glycerin, crude, not purified—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1907	1 cent per pound	37,002,018	$2,366,482	$370,020	$0.064	15.64
1908	do	31,432,874	2,357,228	314,328	.075	13.33
1909	do	35,359,240	2,919,483	353,592	.083	12.11
1910	do	40,888,934	3,622,260	408,889	.090	11.29
1911	do	40,057,708	4,320,661	400,577	.108	9.27
1912	do	29,734,347	3,649,582	297,343	.123	8.15
1913	do	34,143,457	4,217,843	341,434	.124	8.10
1914	do	36,008,209	4,445,747	360,082	.123	8.10
1915	do	18,353,990	2,147,341	183,539	.117	8.55
1916	do	10,558,068	2,155,283	105,580	.204	4.90
1917	do	3,686,919	1,148,611	36,869	.312	3.21
1918	do	1,447,806	609,660	14,478	.421	2.37
1919	do	911,523	301,883	9,115	.331	3.02
Calendar year:						
1918	do	1,087,163	467,418	10,872	.429	2.33
1919	do	3,564,237	417,774	35,642	.117	8.53
1920	do	12,406,827	1,515,034	124,068	.122	8.18
FROM CUBA.						
Fiscal years:						
1907	1 cent per pound less 20 per cent.	134,794	$8,282	$1,078	$0.061	13.02
1908	do	138,477	10,300	1,107	.074	10.76
1909	do	135,657	10,999	1,085	.081	9.87
1910	do	135,778	12,745	1,086	.094	8.52
1911	do	135,096	18,638	1,080	.138	5.80
1912	do	249,396	31,586	1,995	.127	6.32
1913	do	255,672	29,189	2,045	.114	7.01
1914	do	222,183	27,431	1,777	.123	6.48
1915	do	307,939	38,027	2,463	.123	6.48
1916	do	316,990	54,327	2,535	.171	4.67
1917	do	377,962	106,793	3,023	.286	2.83
1918	do	428,495	195,591	3,427	.456	1.75
1919	do	252,429	66,797	2,019	.265	3.02
Calendar years:						
1918		385,106	162,018	3,080	.425	1.90
1919		249,393	27,023	1,995	.108	7.38
1920 [1]		5,677	823	45	.145	5.46

[1] Six months ending June 30, 1920.

Glycerin, refined—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	3 cents per pound	953,106	$87,993	$28,593	$0.092	32.49
1908	do	916,314	100,613	27,489	.109	27.32
1909	do	539,740	60,017	16,192	.111	26.98
1910	do	5,342	1,507	160	.282	10.63
1911	do	74,238	15,335	2,227	.207	14.52
1912	do	51,105	10,448	1,533	.204	14.67
1913	do	8,971	2,564	269	.286	10.50
1914	do	2,607	638	78	.245	12.26
	2 cents per pound	334,381	57,868	6,687	.173	11.56
1915	do	208,260	37,917	4,165	.181	10.99
1916	do	303,463	132,469	6,069	.437	4.58
1917	do	137,128	76,361	2,742	.555	3.59
1918	do	19,750	17,438	395	.883	2.27
1919	do	325,832	67,597	7,516	.207	9.64
Calendar years:						
1918	do	137,826	78,467	2,757	.569	3.51
1919	do	39,059	4,471	781	.114	17.47
1920 [1]	do	1,911,237	414,300	38,224	.216	9.22

[1] Six months ending June 30, 1920.

Glycerin—Domestic exports.

FISCAL YEARS.

Exported to—	1918	
	Quantity.	Value.
	Pounds.	
Italy	18,886,974	$9,385,024
Canada	1,436,922	783,931
France	410,940	58,645
United Kingdom	217,414	116,572
All other	93,741	243,359
Total	21,045,991	10,587,531

CALENDAR YEARS.

Exported to—	1918		1919		1920 [1]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	3,100	$2,530	1,280	$500	.....	.....
Italy	12,133,339	6,163,011	20	5	.....	.....
United Kingdom	6,822,744	3,873,233	22,682	4,103	.....	.....
Canada	1,851,937	1,107,249	119,965	50,736	.....	.....
Mexico	13,331	10,645	60,530	16,635	.....	.....
Cuba	25,516	17,959	109,124	33,505	.....	.....
Japan	831,768	540,016	2,459,097	755,380	.....	.....
All other	73,093	41,984	1,190,694	330,120	.....	.....
Total	21,754,728	11,766,636	3,963,392	1,190,984	1,522,079	$374,928

[1] 10 months ending Oct. 31, 1920. Not stated by countries.

Glycerin, chemically pure, in bulk, per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
Jan. 1, 1912	17½–18	Apr. 3, 1916	57 –58
Apr. 1, 1912	16½–16¾	July 3, 1916	50 –51
July 1, 1912	19 –19½	Oct. 2, 1916	42½–44
Sept. 30, 1912	18½–18¾	Oct. 1, 1917	68
Dec. 30, 1912	18½–19	Dec. 31, 1917	68 –69
Mar. 31, 1913	20 –20½	January, 1918	67½–69
June 30, 1013	19½–19¾	April, 1918	67 –68
Sept. 29, 1913	20¾–21	July, 1918	64 –64½
Dec. 29, 1913	20½–20¾	October, 1918	59 –60
Mar. 30, 1914	20 –20½	January, 1919	20 –21
June 29, 1914	19½–20	April, 1919	16½–17
Sept. 28, 1914	25	July, 1919	20 –21
Dec. 28, 1914	22 –22½	October, 1919	19½–20
Mar. 29, 1915	20	January, 1920	24 –24½
June 28, 1915	22 –22½	April, 1920	23½–24
Sept. 27, 1915	27 –30	July, 1920	28 –28½
Jan. 3, 1916	52½–55	October, 1920	28 –28.

Glycerin, 30°, yellow distilled, per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
Jan. 3, 1916	43 –45	October, 1918	58½–59
Apr. 3, 1916 [1]	56 –57	January, 1919	17½–18
July 3, 1916 [2]	47½–50½	April, 1919	17 –17½
Oct. 2, 1916	45 –47	July, 1919	18 –18½
Oct. 1, 1917	69 –70	October, 1919	18½–19
Dec. 31, 1917	68	January, 1920	23½–24
January, 1918	67	April, 1920	23 –23½
April, 1918	67	July, 1920	27½–28
July, 1918	63½–64	October, 1920	28 –28½

[1] 60°.

[2] Yellow distillate.

Glycerin saponification, loose, per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
Jan. 1, 1912 [1]	14 -15	Apr. 3, 1916	45 -46
Apr. 1, 1912 [1]	14½-15½	July 3, 1916	38½-40
July 1, 1912 [1]	16½-17½	Oct. 2, 1916	34½-35½
Sept. 30, 1912	16 -17½	Oct. 1, 1917	54 -55
Dec. 30, 1912	14 -15	Dec. 31, 1917	49
Mar. 31, 1913	16 -16½	January, 1918	48½-49½
June 30, 1913	14½-15½	April, 1918	51½-52
Sept. 29, 1913	16½-17	July, 1918	49 -50
Dec. 29, 1913	16½-17	October, 1918	39 -40
Mar. 30, 1914	16 -16½	January, 1919	11 -12
June 29, 1914	16½-17	April, 1919	9 -10
Sept. 28, 1914	16½-17½	July, 1919	11½
Dec. 28, 1914	16 -16½	October, 1919	13½-14½
Mar. 29, 1915	13½-14	January, 1920	18 -18½
June 28, 1915	(2)	April, 1920	15 -16
Sept. 27, 1915	(2)	July, 1920	20 -20½
Jan. 3, 1916	43 -45	October, 1920	19 -19½

[1] "Loose" omitted.

[2] Nominal.

Glycerin, dynamite, per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
Jan. 1, 1912	16½-17	Apr. 3, 1916 [1]	55 -56
Apr. 1, 1912	15½-15½	July 3, 1916 [1]	47 -50
July 1, 1912	18½-19	Oct. 2, 1916	45 -47
Sept. 30, 1912	18	Oct. 1, 1917	69 -70
Dec. 30, 1912	18½-19	Dec. 31, 1917	63 -65
Mar. 31, 1913	20 -20½	January, 1918	64 -65
June 30, 1913	18½-19	April, 1918	66 -67½
Sept. 29, 1913	20 -20½	July, 1918	62 -63
Dec. 29, 1913	19½-20	October, 1918	58 -59
Mar. 30, 1914	19½-19½	January, 1919	17 -18
June 29, 1914	19½-19½	April, 1919	15 -16
Sept. 28, 1914	24 -24½	July, 1919	18½-19
Dec. 28, 1914	21 -21½	October, 1919	19½-20
Mar. 29, 1915	18½-19	January, 1920	24 -25
June 28, 1915	21 -21½	April, 1920	21½-22
Sept. 27, 1915	Nominal.	July, 1920	27½-28
Jan. 3, 1916 [1]	45 -55	October, 1920	27½-28

[1] Drums included.

Glycerin, chemically pure, in cans, per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
Jan. 1, 1912 [1]	18½-19	Apr. 3, 1916	58 -59
Apr. 1, 1912 [1]	17½-17½	July 3, 1916	51 -52
July 1, 1912	20 -20½	Oct. 2, 1916	43½-45
Sept. 30, 1912	19½-19½	Dec. 31, 1916	69½-70½
Dec. 30, 1912	19½-20	December, 1917	71½-72
Mar. 31, 1913	21 -21½	January, 1918	64 -65
June 30, 1913	20½-20½	April, 1918	68½-69
Sept. 29, 1913	21½-22	July, 1918	66 -66½
Dec. 29, 1913	21½-21½	October, 1918	60 -61
Mar. 30, 1914	21 -21½	January, 1919	22 -23
June 29, 1914	20½-21	April, 1919	18½-19
Sept. 28, 1914	26	July, 1919	22 -23
Dec. 28, 1914	23 -23½	October, 1919	21½-22
Mar. 29, 1915	21	January, 1920	22 -22½
June 28, 1915	23 -23½	April, 1920	25 -25½
Sept. 27, 1915	28 -30	July, 1920	29 -30
Jan. 3, 1916	53½-56	October, 1920	30½-31

[1] In cases.

Glycerin, soap lye, loose, per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
Jan. 1, 1912[1]	12 -13	Apr. 3, 1916	39 -40
Apr. 1, 1912[1]	11½-13½	July 3, 1916	35 -39
July 1, 1912[1]	15½-16½	Oct. 2, 1916	31½-32½
Sept. 30, 1912[1]	15 -15½	Oct. 1, 1917	48 -50
Dec. 30, 1912	13 -13½	Dec. 31, 1917	44 -
Mar. 31, 1913	14½-15½	January, 1918	44½-45
June 30, 1913	12½-13	April, 1918	51½-52
Sept. 29, 1913	14½-14½	July, 1918	44½-45
Dec. 29, 1913	14½-14½	October, 1918	36 -37
Mar. 30, 1914	13½-14	January, 1919	9 -10
June 29, 1914	14 -14½	April, 1919	8 -9
Sept. 28, 1914	15 -16	July, 1919	10½-
Dec. 28, 1914	14½-15	October, 1919	12 -13
Mar. 29, 1915	12½-12½	January, 1920	16½-17
June 28, 1915	15 -17	April, 1920	13½-14
Sept. 27, 1915	nominal.	July, 1920	18 -18½
Jan. 3, 1916	39 -43	October, 1920	17½-18

[1] Crude lye.

Glycerin, refined, wholesale at New York, spot.

[From Oil, Paint, and Drug Reporter. Averages made from quotations taken on first Saturday each month.]

	Per pound.		Per pound.
1890-1899	$0.1399	1909	$0.1700
1900	.1515	1910	.2142
1901	.1501	1911	.2269
1902	.1444	1912	.1842
1903	.1416	1913	.1971
1904	.1396	1914	.2148
1905	.1238	1915	.2960
1906	.1129	1916	.5079
1907	.1383	1917	.6113
1908	.1492		

Glycerin—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	4	Glycerin, crude, brown, or yellow, of the specific gravity of 1.25 or less, at a temperature of 60° F., not purified by refining or distilling.	2 cents per pound.
	5	Glycerin, refined	5 cents per pound.
1890	28	Glycerin, crude, not purified	1¼ cents per pound.
		Refined	4½ cents per pound.
1894	20	Glycerin, crude, not purified	1 cent per pound.
		Refined	3 cents per pound.
1897	24	Glycerin, crude, not purified	1 cent per pound.
		Refined	3 cents per pound.
1909	24	Glycerin, crude, not purified	1 cent per pound.
		Refined	3 cents per pound.
1913	35	Glycerin, crude, not purified	1 cent per pound.
		Refined	2 cents per pound.

Court and Treasury Decisions.

Glycerin, brown in color and slightly above the specific gravity of 1.25, partially refined by distillation, was held dutiable as glycerin refined and not as "glycerin, crude, brown or yellow, of the specific gravity of 1.25 or less at a temperature of 60° F., not purified by refining or distilling" under the act of 1883. (Appeal of Wolf, T. D. 6048.)

So was partially refined yellow glycerin of a specific gravity of slightly less than 1.25, water having been added to reduce the specific gravity. (Appeal of Schloesser, T. D. 6648.)

The Treasury Department refused in 1900 to establish a line of demarcation between crude and refined glycerin, and directed that in case of doubt a sample should be transmitted to the collector at New York for analysis and report. (Dept. Order, T. D. 22258.)

In a case in which the Board of General Appraisers held glycerin, invoiced as "crude saponification glycerin," to be dutiable as crude rather than as refined, the Court of Customs Appeals held that the board erred in its ruling that the Government, as a condition precedent to the admission of evidence of analysis, must produce a sample of the substance analyzed, and remanded the cause for retrial. (United States *v.* Alpers, 4 Ct. Cust. Appls., 19 (T. D. 33201).)

Glycerin in plain glass bottles less than 2½ pounds gross weight was held dutiable at 20 per cent ad valorem by reason of the provision in paragraph 17 that "chemical and medicinal compounds, combinations, and all similar articles dutiable under this section, except soap, whether specially provided for or not, put up in individual packages of 2½ pounds or less gross weight * * * shall be dutiable at a rate not less than 20 per centum ad valorem," and not at 2 cents per pound under paragraph 35 as glycerin refined. (G. A. 7833; T. D. 36031.)

35284—21—A-9——4

AMBER AND AMBEROID.

[Par. 36, act of 1913, $1 per pound.]

General Information.

Description.—Amber is a fossil resin from various species of extinct conifers and is found principally along the shores of the Baltic in eastern Germany. Originally it was obtained almost entirely on the seashore where it was picked up after storms or obtained by dredging. At present most of the amber is obtained from mines in Samland, East Prussia. It is found in a blue earth in the cretaceous formation at a depth of 108 feet and 46 feet below sea level.

Amber varies in color from pale yellow to red, brown, or even black, and may be transparent, translucent or opaque. It is found principally in small pieces, the largest mass yet found weighing 13 pounds.

Amberoid is produced by forming small bits and chips of amber into a solid cake by means of heat and hydraulic pressure. In some cases, before pressing, it is mixed with small quantities of copal resin and camphor.

Uses.—The finest amber and amberoid are used for making beads and other ornaments, mouthpieces for pipes, cigar holders, etc. The smaller bits and chips of amber are used in making amberoid and for some kinds of varnish. It produces a very hard varnish but it too expensive to be of general use.

Domestic production.—The United States produces no amber, though small quantities have been found in Maryland and New Jersey, and on Marthas Vineyard. In none of these localities does it occur in commercial quantities.

Foreign production.—Most of the world's supply of amber comes from Samland, East Prussia, though small amounts are sometimes found after storms on the coasts of England, Denmark, and Scandinavia. Amber occurs in considerable quantity in Sicily and a mine is reported to have been discovered near Rockwood, Australia.

In 1907 the mines of Samland produced 891,328 pounds of amber, while about 44,100 pounds were collected on the seashore.

In 1913 Germany exported 94,798 pounds of crude amber, valued at $254,660, and 93,475 pounds of "amber chips, amberoid, and jet." The mines of Samland are under the control of the German Government.

Imports.—All the amber used in the United States comes from the Baltic. In 1913 the imports of crude amber and amberoid amounted to 35,645 pounds, valued at $339,984, but since the beginning of the war these imports have greatly decreased. In 1917 only 36 pounds were imported. (See table on p. 51.)

Tariff history.—Amber and amberoid have been on the free list under all tariff acts except the act of 1913, which placed a duty of $1 per pound on them.

Competing substances.—Amber is now being replaced in the manufacture of ornamental articles by an artificial product which resembles

amber in appearance and physical properties, but differs greatly in chemical nature. These so-called "synthetic resins" are made by the chemical combination of phenol with formaldehyde or hexamethylene-tetramine. They are chemically more stable than amber. Such substances are bakelite, condensite, and redmanol. The manufacture of these synthetic products has increased greatly in the United States within the past few years, and the claim is made that they are equal to or better than amber for most purposes. There are two varieties of these, one which is plastic and used largely for electrical insulations and another which is nonplastic. Only the nonplastic variety, which is the more expensive to produce, competes with amber.

Exports of amber from Germany.[1]

Year.	Crude.		Amber, chips, amberoid jet, etc.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	56,879	$197,064	75,838	$424,830
1911	61,027	209,916	86,200	461,482
1912	83,673	233,478	75,838	378,896
1913	94,798	254,660	93,475	402,696

[1] Figures from Vierteljahrhefte zur Statistik des Deutschen Reichs.

Amber and amberoid, crude—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1908	Free	32,306	$248,423		$7.69	
1909	do	37,903	313,517		8.27	
1910	do	56,573	451,078		7.97	
1911	do	54,606	436,692		8.00	
1912	do	35,663	338,821		9.50	
1913	do	35,645	339,984		9.54	
1914	do	12,081	109,934		9.10	
1914[1]	$1 per pound	10,404	107,441	$10,404	10.33	9.68
1915	do	9,856	103,136	9,856	10.46	9.56
1916	do	443	3,599	443	8.12	12.31
1917	do	36	324	36	9.00	11.11
1918	do	734	1,280	734	1.74	57.34
1919	do	69	685	69	9.92	10.07
Calendar year:						
1918	do	25	222	25	8.88	11.11
1919	do	768	4,278	768	5.57	17.95
1920[2]	do	2,696	8,298	2,696	3.078	32.49

[1] Amber in chips imported in 1914, 23 pounds, value $9.

[2] 6 months.

Amber and amberoid—Rates of duty.

Act of—	Sec.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	2503	Amber beads and gum	Free.
1890	479	Amber, unmanufactured, or crude gum	Do.
1894	369	Amber, and amberoid, unmanufactured, or crude gum	Do.
1897	470	do	Do.
1909	488	Amber, and amberoid, unmanufactured, or crude gum, gum kauri, and gum copal.	Do.
1913	36	Gums: Amber and amberoid, unmanufactured or crude gum, not specially provided for in this section.	$1 per pound.

GUM ARABIC OR SENEGAL.

General Information.

Gum arabic is the dried gummy exudation from *Acacia senegal* Willd., or from other African species of *Acacia* (family Leguminosæ).

SYNONYMS.

Acacia, U. S. P., Acacia gummi, Br. P. Galam gum, gum senegal (in part).

CLASSIFICATION.

Gum arabic is the chief member of the so-called arabin series of gums, as distinguished from the bassorin series, represented by tragacanth.

VARIETIES.

With regard to the gums collectively or severally known as "gum arabic," it must be admitted that in the present state of our knowledge of the botany and chemistry of the tropical *Acacias* (an unusually difficult genus), and because of the variability of the gum of the same species, the frequent mixture of the products of different species and countries by collectors and handlers, the devious ways in which some of the gums enter the trade, and the chaotic state of trade nomenclature, a wholly satisfactory and definite classification is impossible. As these gums are chiefly used for technical consumption, a definite classification and standard is somewhat less essential than would be the case were they chiefly used for food or drug purposes. For the present purpose the following is adapted from that used by Watt, in his study of the Indian gums. We may thus recognize (1) true gum arabics (limiting the term somewhat more than the bare definition of the Pharmacopœia, as given above), and (2) substitute gums of closely related but more or less uncertain origin, and very variable quality, many of which, to a greater or less degree, approach or comply with pharmacopœial requirements.

TRUE GUM ARABICS.

The term acacia, or gum arabic, originally referred to Kordofan, Sudan, Turkish, or Egyptian gum, in the vernacular hashab, the product of lower Egypt, Kordofan, and the Sudan region. Neither this nor any similar commercial product originates in Arabia. This gum is the most valuable product of its class known to commerce. During the political and military disturbances in Egypt between 1880 and 1890 this gum became practically unobtainable, and numerous substitutes were introduced. The best of these was gum senegal

(vernacular, verek), so called from the region producing it. It has been claimed by some authorities that both gums are produced by *Acacia senegal* Willd., but it is more likely that the Kordofan gum, and not improbably the better grades of Senegal gum, are from the closely related *A. verek*. After 1890 the trade in Kordofan gum was again opened; both now occur on the market and are not usually clearly differentiated.

Trade in Kordofan gum formerly centered in Trieste, whence the product came from Cairo, Alexandria, and other Egyptian ports for sorting. The gum as collected is of extremely variable quality, and requires careful selection. Thirty-two grades are recognized in Trieste; about five are quoted in our markets. Bases of selection are absence of color, purity, insipidity, solubility, viscosity, and permanence in solution. In recent years Trieste has lost its preeminence as a gum market; much sorting takes place at Khartown, and trade moves largely through Hamburg, Bordeaux, and London, and a considerable amount from African ports to New York.

Gum senegal was introduced by the Dutch, but the French planted a colony at the mouth of the Senegal and took possession of the trade. Export is from St. Louis, West Africa. Formerly trade centered in Bordeaux; now, like that in Kordofan gum, it has become more general.

SUBSTITUTES.

As has been previously indicated, it is at present impossible always to draw a definite dividing line between "true gum arabics" and "substitutes," either from a geographical, botanical, or chemical or technical standpoint. Many gums to be noted under the present caption are undoubtedly, in part at least, identical in botanical origin and equivalent in quality to those treated under "true gum arabics." Their quality and appearance, however, are in general less constant and uniform; both are influenced, doubtless, by variations in climate and soil of the regions whence they are derived. Their value and trade importance are conditioned by their resemblance to the better grades of Kordofan and Senegal gum, their constancy of character, purity, absence of color (or presence of definite colors for special purposes), lack of distinctive taste, solubility, viscosity, and stability in solution. They may be grouped conveniently into the products of other Acacia and closely related species, natural gums produced by plants unrelated to Acacia, and artificial substitutes.

Acacia gums.—African acacias. These, while apparently included in the pharmacopœial definition, in general fall below the standards of quality provided for Acacia in its official uses, and therefore may be considered as substitutes.

Suakin gum.—This term, derived from their usual center of export, refers to various inferior gums produced in the Nile region. and includes for instance the Gedda, Ghedda, Gehzirah, Kassala, Massowah, Sennaar, and Blue Nile gums. They have usually a sour or fermented odor.

Magador gum.—This product, also termed Barbary, Morocco, or (vernacular) attahar gum, is a dark-colored gum attributed to *A. nilotica* Desf. and *A. arabica* Willd., exported from Morocco.

Other African gums are Talea, probably more or less synonymous with Suakin, and Cape or Angra Pequena gum, and Camelthone gum of South Africa.

"East Indian" acacia gums.

The term "East Indian" is not indicative of the actual geographical origin, but is due to the fact that the trade centers in Bombay. These gums are here received from Aden and other Red Sea ports; they are mainly the produce of Africa; they differ from gum senegal somewhat in appearance but are little inferior to it, though being less carefully sorted. They are reported to be frequently adulterated in Bombay. Two trade varieties are recognized: Maklai, from Makalla, Arabia, and maswai, from Massowa, Abyssinia.

Indian acacia gums.—Formerly these were of no importance outside India, but their export trade since 1895 has exceeded that of "East Indian" gum. About 30 Indian acacias yield gum, and the export product is therefore a badly mixed article. Most clearly differentiated is Amrad, Oomra watti, Babool or Ghatti (in part) gum, which is mainly the product of *Acacia arabica*, the Indian gum-arabic or Babool tree. It is a dark product, usually fit only for technical purposes.

Acacia arabica is a cultivated tree, grown mainly for its bark, which is valued in India as a tan, for its wood (fuel), as a host for the lac insect, and for other local uses; the gum, however, is said to be less freely produced in cultivation than in the tree's wild state, and may be said to be a minor product of the tree. In quality it is much inferior to that of many other species, which however, occur much less plentifully, and consequently are of no commercial importance. Of minor consequence may be mentioned the gum of *Acacia jacquemontii*, exported from Karachi as Sind gum and from Bombay as Amritsar gum (in part); this is similar to that of *A. arabica* but of better quality. Sundragum, from Tuticorin and elsewhere on the Malabar coast, is produced by *A. catechu*, the source of cutch of commerce. It is a gum of fairly good quality. *A. senegal* also occurs in northern India, and small quantities of its gum have been shipped from Karachi. Bombay is the center of foreign trade for Indian as well as "East Indian" gums.

Australian acacias.—Australian gums or wattle gum, is the product of numerous acacias, chiefly that of *A. pyenantha* Beuth. These gums appear not to be suitable for pharmaceutical purposes, but are of technical value. Exports at present appear to be negligible.

American Acacias and related species.—Para, or Brazilian gum, or gum angico, is a dark but very adhesive gum attributed to *Acacia angico*. It should not be confused with a gum-resin known also as Brazilian gum, said to be obtained from *Hymenaea courbarii*, and used in varnish manufactures. Goma brea is another South American product, yielded by *Caesalpinia praecox* R. and B. *Prosopis juliflora* D. C., the mesquite of the Southwest and Mexico, yields an excellent gum, but in small quantities.

Gums from sources not related to acacia.—The most important of these are of Indian origin. Guzarat or wood-apple gum, from *Feronia elephantum* W. & A. (family Rutaceae), is said to be the most valuable. Ghatti gum (for the most part), Lahore, or Dhaura gum is exported in considerable quantity from Bombay, French India, and northern Nigeria. It is the product of *Anogeissus latifolia* Wall.

and is official in the British Pharmacopœia. Jingan gum, from *Odina wodier* Roxb., is largely used in India, but probably is not exported save in mixture with other gums. Large numbers of other gums, orginating in India and other countries, and from most various botanical sources, have been utilized more or less locally, but at present their commercial importance is not sufficient to justfy mention in this connection.

ARTIFICIAL SUBSTITUTES.

The more important substances employed in some of the various uses of gum arabic—dextrin, starch, gelatin, glue, etc., and their modifications - are dealt with under appropriated headings. Products made specifically as gum-arabic substitutes are usually preparations of hydrolized starch. Schumann's universal gum was made by hydrolysis of starch with sulphuric acid at high temperature and pressure, neutralizing, and drying. Another substitute has been made by a somewhat similar treatment of linseed. Carrageenin, or mucilage of Irish moss, a pectin-like substance prepared from the seaweed *Chondrus crispus* (L) Stackhouse, has been offered as imitation gum arabic.

Among drugs used in part for similar purposes, but hardly to be classed as substitutes, may be named tragacanth, sassafras, salep, quince seed. linseed, and marshmallow.

ADULTERANTS.

As indicated in part in the preceding paragraphs, gum arabic of commerce is subject to frequent adulteration, both with the substances mentioned and many others of known and unknown origin. Bassora Kuthira, or Kutira gum, a Persian product, known in India as Hogg gum, is frequently found in Indian importations. It is from *Cochlospernum gossypium* D. C. (family Bixaceae).

PRODUCTION.

The African acacias are small, thorny trees forming entire forests in the sandy soil and near deserts of northern and central Africa. The gum is a product of the degeneration of the cell structure of the inner-bark tissues; it exudes as a thick juice through natural or artificial wounds; this process of "gummosis" is therefore pathological and allied to the gummosis of the peach, plum, and certain other trees; like these, too, the etiology of the disease is obscure. Some investigators have ascribed a causative rôle to bacteria and certain fungi. Wounds from which gum extrudes are plentifully formed by cracking of the bark in hot weather, attacks of insects, and by a parasitic plant which punctures the bark. Occasionally, especially in the case of Kordofan gum, the trees are wounded by collectors. The flow of gum is very variable, the most being produced by unhealthy trees and in dry, hot seasons. Gum arabic is collected between October and December by Moors and Negroes, traveling in caravans.

Collection of acacia gums in India is a desultory occupation rather than an organized or regular business.

USES.

Gum arabic (acacia) is official in all pharmacopœias. It is demulcent and emollient, possessing a slight medicinal action, and for its own effect is used in local applications to inflamed mucous membranes. Official preparations are the mucilage and sirup of acacia. Acacia is of chief pharmaceutical importance as a mucilaginous vehicle for more powerful remedies, as an emulsifying agent to hold insoluble drugs in suspension, and as a pill excipient. Only the finer grades of gum arabic are used in pharmacy.

The purest and whitest grades of gum arabic are employed in the preparation of liqueurs, in sizing for silks and laces, and in aquarelles. Cheaper grades are used as sizing for various fabrics, in calico printing, also in match manufacture and in water colors, water paints, and kalsomines. Gum arabic is of extreme importance as a source of mucilages and adhesives; over 220,000 pounds is said to be used annually in Germany on postage stamps. Gum arabic is used in confectionery, and also in some of its places of origin as a foodstuff, though it has little nutritive value. The poorest grades are used in inks.

Exports of gum arabic from Egypt.

Countries.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
England	312,811	$14,221	1,377,702	$73,346	853,681	$47,039
France	291,997	13,124	302,174	16,075	789,807	43,420
Italy	240,629	10,885	262,933	13,964	197,985	10,731
Germany	815,325	36,673	1,418,067	75,501	1,025,193	55,857
Austria-Hungary	390,810	17,696	373,538	19,743	300,637	16,702
United States	1,252,940	56,302	2,425,685	129,534	1,801,556	97,463
All other	1,186,812	53,864	1,250,900	66,410	1,040,267	57,533
Total	4,491,324	202,765	7,410,999	394,573	6,009,126	328,745

Exports of gum arabic from Egypt.

Countries.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
England	982,894	$56,861	219,622	$14,473	71,997	$4,211
France	617,553	35,259	296,747	17,681	386,716	22,590
Italy	94,453	5,432	51,506	3,010	240,383	14,053
Germany	1,210,268	69,727	306,167	18,270	96,259	5,620
Austria-Hungary	413,514	23,865	130,614	7,736	117,660	6,876
United States	1,751,442	101,868	233,464	14,849	80,962	4,731
All other	1,678,028	96,746	1,061,284	64,498	301,138	17,592
Total	6,748,152	389,758	2,299,404	140,517	1,295,115	75,673

Exports of gum arabic from Egypt—Continued.

Countries.	1915		1916	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
England	212,419	$14,167	142,052	$10,212
France	309,307	20,850	456,209	36,767
Italy	117,429	7,009	432,076	38,858
Germany	.....	.....	.....	.....
Austria-Hungary	.....	.....	.....	.....
United States	475,576	30,034	29,627	2,130
All other	325,967	21,493	328,153	29,629
Total	1,440,698	93,553	1,398,177	117,596

Imports of gum arabic into the United Kingdom.

Countries.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	1,263,584	$89,690	789,936	$54,407	481,936	$45,876
Egypt	5,246,640	388,673	6,298,656	511,401	10,025,904	906,313
South Nigeria	864,640	43,531	1,091,552	57,610	1,089,312	56,072
North Nigeria	.....	.....	.....	.....	.....	.....
British India	776,832	43,263	716,688	48,295	722,848	49,526
All other	1,335,824	87,616	3,128,496	185,112	1,775,088	124,694
Total	9,487,520	652,773	12,025,328	856,825	14,095,088	1,182,481

Countries.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	537,824	$47,006	1,132,992	$79,100	1,365,504	$111,579
Egypt	15,774,416	1,368,543	10,440,304	825,193	9,200,688	28,990
South Nigeria	1,085,168	56,558	6,944	365	.....	.....
North Nigeria	.....	.....	1,295,168	68,282	.....	.....
British India	533,120	38,226	719,488	45,351	963,312	62,914
All other	1,029,840	80,648	1,331,792	99,987	1,588,608	835,208
Total	18,960,368	1,590,981	14,926,688	1,118,278	13,118,112	1,038,691

Countries.	1915		1916	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
France	888,384	$91,261	814,576	$116,465
Egypt	9,794,848	780,188	16,457,616	1,927,577
South Nigeria	.....	.....	.....	.....
North Nigeria	613,088	33,204	705,600	36,440
British India	1,168,160	74,297	1,179,024	92,989
All other	4,367,104	262,455	683,312	72,112
Total	16,831,584	1,241,405	19,840,128	2,245,583

Exports of gum arabic from India.

Countries.	1909–10		1910–11		1911–12	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	586,096	$35,034	753,200	$45,044	677,712	$47,307
Germany	834,512	41,652	1,234,688	69,990	2,178,848	138,647
United States	171,136	9,514	416,864	23,700	551,936	36,352
All other	2,342,256	100,469	2,723,056	142,769	1,931,776	112,650
Total	3,934,000	186,669	5,127,808	281,503	5,340,272	334,956

Countries.	1912–13		1913–14		1914–15	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	382,144	$23,267	664,944	$37,959	715,792	$36,815
Germany	1,743,952	104,119	1,756,160	100,119	494,144	28,659
United States	749,952	63,897	975,408	79,129	291,760	19,004
All other	986,496	55,848	1,608,880	86,876	822,640	40,951
Total	3,862,544	247,131	5,005,392	304,083	2,324,336	125,429

Countries.	1915–16	
	Quantity.	Value.
	Pounds.	
United Kingdom	1,064,896	$58,529
United States	44,352	2,891
All other	279,552	19,977
Total	1,388,800	81,397

Gum arabic—Imports for consumption—Revenue.

	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				
1914	½ cent per pound	3,492,682	$240,066	$17,463	$0.069	7.27
1915	do	5,184,265	402,507	25,921	.077	6.44
1916	do	7,613,880	679,388	38,069	.089	5.60
1917	do	7,473,234	881,345	37,366	.118	4.24
1918	do	6,033,341	1,242,281	30,166	.205	2.43
Calendar year:						
1918	do	6,115,190	1,237,379	30,576	.202	2.47
1919	do	7,076,663	950,859	35,383	.124	3.72
1920 [1]	do	4,319,172	489,463	21,595	.113	4.41

[1] Six months ending June 30, 1920.

Gum senegal, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

SORTS.

	Cents.		*Cents.*
Jan. 1, 1912	11½–12¾	Sept. 27, 1915	10 –12¾
Apr. 1, 1912	11½–12¾	Jan. 3, 1916	10 –12¾
July 1, 1912	11½–12¾	Apr. 3, 1916	18 –20
Sept. 30, 1912	11½–12¾	July 3, 1916	18 –20
Dec. 30, 1912	11½–12¾	Oct. 2, 1916	18 –20
Mar. 31, 1913	11½–12¾	Jan. 1, 1917	18 –20
June 30, 1913	11½–12¾	Apr. 2, 1917	18 –20
Sept. 29, 1913	11½–12¾	July 2, 1917	18 –20
Dec. 29, 1913	11½–12¾	Oct. 1, 1917	31 –34
Mar. 30, 1914	11½–12¾	Dec. 31, 1917	31 –34
June 30, 1914	11½–12¾	January, 1920	17 –19
Sept. 28, 1914	10 –12¾	April, 1920	16 –18
Dec. 28, 1914	10 –12¾	July, 1920	16 –18
Mar. 29, 1915	10 –12¾	October, 1920	16 –18
June 28, 1915	10 –12¾		

PICKED.

	Cents.		*Cents.*
Jan. 1, 1912	14–22	Sept. 27, 1915	18 –19
Apr. 1, 1912	14–22	Jan. 3, 1916	18½–20
July 1, 1912	14–22	Apr. 3, 1916	22 –24
Sept. 30, 1912	14–22	July 3, 1916	22 –24
Dec. 30, 1912	14–22	Oct. 2, 1916	22 –24
Mar. 31, 1913	14–22	Jan. 1, 1917	22 –24
June 30, 1913	14–22	Apr. 2, 1917	22 –24
Sept. 29, 1913	14–22	July 2, 1917	22 –24
Dec. 29, 1913	14–22	Oct. 1, 1917	35 –40
Mar. 30, 1914	14–22	Dec. 31, 1917	35 –40
June 30, 1914	14–22	January, 1920	34 –35
Sept. 28, 1914	18–19	April, 1920	33 –35
Dec. 28, 1914	18–19	July, 1920	33 –35
Mar. 29, 1915	18–19	October, 1920	33 –35
June 28, 1915	18–19		

Gum arabic, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

FIRSTS.

	Cents.		*Cents.*
Jan. 1, 1912	25–35	Sept. 27, 1915	30–35
Apr. 1, 1912	25–35	Jan. 3, 1916	30–35
July 1, 1912	25–35	Apr. 3, 1916	30–35
Sept. 30, 1912	25–35	July 3, 1916	30–35
Dec. 30, 1912	25–35	Oct. 2, 1916	30–35
Mar. 31, 1913	25–35	Jan. 1, 1917	38–40
June 30, 1913	25–35	Apr. 2, 1917	43–45
Sept. 29, 1913	25–35	July 2, 1917	43–45
Dec. 29, 1913	25–35	Oct. 1, 1917	52–55
Mar. 30, 1914	25–35	Dec. 31, 1917	52–55
June 29, 1914	25–35	January, 1920	33–36
Sept. 28, 1914	38–40	April, 1920	33–36
Dec. 28, 1914	35–40	July, 1920	31–34
Mar. 29, 1915	35–40	October, 1920	30–31
June 28, 1915	25–35		

SECONDS.

	Cents.		*Cents.*
Jan. 1, 1912	19–23	Sept. 27, 1915	28–30
Apr. 1, 1912	19–23	Jan. 3, 1916	28–30
July 1, 1912	19–23	Apr. 3, 1916	28–30
Sept. 30, 1912	19–23	July 3, 1916	28–30
Dec. 30, 1912	19–23	Oct. 2, 1916	28–30
Mar. 31, 1913	19–23	Jan. 1, 1917	36–37
June 30, 1913	19–23	Apr. 2, 1917	40–42
Sept. 29, 1913	19–23	July 2, 1917	40–42
Dec. 29, 1913	19–23	Oct. 1, 1917	-----
Mar. 30, 1914	19–23	Dec. 31, 1917	-----
June 29, 1914	19–23	January, 1920	(1)
Sept. 28, 1914	30–35	April, 1920	(1)
Dec. 28, 1914	24–26	July, 1920	(1)
Mar. 29, 1915	24–26	October, 1920	(1)
June 28, 1915	24–26		

[1] Nominal.

Gum arabic, prices per pound, wholesale, New York, spot—Continued.

THIRDS.

	Cents.		Cents.
Jan. 1, 1912	15–25	Mar. 29, 1915	22–24
Apr. 1, 1912	15–25	June 28, 1915	22–24
July 1, 1912	15–25	Sept. 27, 1915	25–28
Sept. 30, 1912	15–25	Jan. 3, 1916	25–28
Dec. 30, 1912	15–25	Apr. 3, 1916	25–26
Mar. 31, 1913	15–25	July 3, 1916	25–26
June 30, 1913	15–25	Oct. 2, 1916	25–26
Sept. 29, 1913	15–25	Jan. 1, 1917	34–35
Dec. 29, 1913	15–25	January, 1920	(1)
Mar. 30, 1914	15–25	April, 1920	(1)
June 29, 1914	15–25	July, 1920	(1)
Sept. 28, 1914	24–26	October, 1920	(1)
Dec. 28, 1914	22–24		

[1] Nominal.

WHITE.

	Cents.		Cents.
Jan. 1, 1912	14–16	Sept. 27, 1915	19–23
Apr. 1, 1912	15–16	Jan. 3, 1916	25–27
July 1, 1912	15–16	Apr. 3, 1916	27–30
Sept. 30, 1912	15–16	July 3, 1916	27–28
Dec. 30, 1912	15–16	Oct. 2, 1916	25–30
Mar. 31, 1913	15–16	Jan. 1, 1917	32–34
June 30, 1913	15–16	Apr. 2, 1917	35–38
Sept. 29, 1913	15–16	July 2, 1917	35–38
Dec. 29, 1913	15–16	Oct. 1, 1917	46–50
Mar. 30, 1914	15–16	Dec. 31, 1917	46–50
June 30, 1914	15–16	January, 1920	30–32
Sept. 28, 1914	22–25	April, 1920	30–32
Dec. 28, 1914	23–25	July, 1920	30–32
Mar. 29, 1915	18–25	October, 1920	30–32
June 28, 1915	18–25		

SORTS, AMBER, CLEANED.

	Cents.		Cents.
Jan. 1, 1912 [1]	11 –11½	Sept. 27, 1915 [1]	16 –18
Apr. 1, 1912 [1]	11 –12	Jan. 3, 1916 [1]	23 –24
July 1, 1912 [1]	11 –12	Apr. 3, 1916 [1]	24 –25
Sept. 30, 1912 [1]	10 –11	July 3, 1916	18 –19
Dec. 30, 1912 [1]	8½– 9	Oct. 2, 1916	15 –17
Mar. 31, 1913 [1]	8½– 9	Jan. 1, 1917	16 –17
June 30, 1913 [1]	8½– 9	Apr. 2, 1917	18 –18½
Sept. 29, 1913 [1]	8½– 9	July 2, 1917	22 –23
Dec. 29, 1913 [1]	8½– 9	Oct. 1, 1917	32 –34
Mar. 31, 1914 [1]	9½–10	Dec. 31, 1917	32 –34
June 29, 1914 [1]	10 –10½	January, 1920	16 –16½
Sept. 28, 1914 [1]	20 –22	April, 1920	15 –16
Dec. 28, 1914 [1]	14 –15	July, 1920	15½–16
Mar. 29, 1915 [1]	12 –13	October, 1920	15½–16
June 28, 1915 [1]	13 –14		

[1] "Cleaned" omitted.

Gum, arabic or senegal—rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	636	Drugs * * * gums * * * not edible * * * in a crude state * * * not advanced * * * and not specially enumerated or provided for.	Free.
1883	94	All * * * gums * * * not edible but which have been advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially enumerated or provided for.	10 per cent.
1890	560	Drugs, such as * * * gums * * * not edible * * * in a crude state * * * not advanced * * * not specially provided for.	Free.
1890	24	Drugs, such as * * * gums * * * not edible * * * advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially enumerated or provided for.	10 per cent.
1894	470	Drugs, such as * * * gums * * * drugs which are not edible * * * not * * * advanced * * * not specially provided for.	Free.

Gum, arabic, or senegal—rates of duty—Continued.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1894	16½	Drugs, such as * * * gums * * * not edible * * * advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially provided for.	10 per cent.
1897	548	Drugs, such as * * * gums * * * which are drugs and not edible * * * in a crude state * * * not advanced * * * not specially provided for.	Free.
1897	20	Drugs, such as * * * gums * * * which are drugs and not edible, but which are advanced in value or condition by refining, grinding, or other process, and not specially provided for.	½ of 1 cent per pound plus 10 per cent ad valorem.
1909	559	Drugs, such as * * * gums * * * which are natural and uncompounded drugs and not edible and not specially provided for * * * in a crude state, not advanced * * * : *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be admitted free of duty under this paragraph.	Free.
1909	20	Drugs, such as * * * gums * * * which are natural and uncompounded drugs and not edible, and not specially provided for * * * but which are advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the drugs, and the prevention of decay or deterioration pending manufacture * * * : *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be classified for duty under this paragraph.	½ of 1 cent per pound plus 10 per cent ad valorem.
1913	36	Gums * * * arabic or senegal * * *.....	½ cent per pound.

Court and Treasury Decisions.

DECISIONS UNDER THE ACT OF 1913.

Ab. 38356. Gum arabic; crude gum. Protest 740933 of Hensel, Bruckmann & Lorbacher (New York).

Brown, General Appraiser. The merchandise here in dispute was invoiced as "Gum insoluble (gum arabic)." It was classified under the provision in paragraph 36, act of 1913, for "gums; * * * arabic or senegal, one-half cent per pound." It is claimed to be free under paragraph 477 as a crude gum not specially provided for.

The question turns on the fact of identity.

The importers' witnesses, Joseph Hanil, of Jacques Wolf & Co.; A. E. Willeneucher, salesman of the National Aniline & Chemical Co.; R. Hillier, foreign representative of dealers in this merchandise, who sold to the importers here for a foreign house; and Charles T. Domeroy, a chemist, testified that this substance is not gum arabic.

The Government's case is based upon the testimony of Dr. Rusby, professor of materia medica in the New York College of Pharmacy and pharmacologist for the United States Government, Department of Agriculture, who described this article as, in his opinion, a low-grade gum arabic; and upon the testimony of Dr. Knight, chemist, who also testified that it was a low-grade arabic.

An analysis of the testimony of Dr. Rusby shows, however, that his conclusion is based, first, upon certain tests he made which indicated to him that it contained a considerable portion of gum arabic. He did not claim that it was entirely gum arabic, but admitted that it was a mixture. After powdering it, he attempted to dissolve it, and he styles the result of such attempt "a fairly good solution." This was offered in evidence as illustrative Exhibit 1, containing what purports to a scientist's mind to be a solution, but what to the ordinary man would be a running mass far

short of a solution. When asked by Judge McClelland (p. 62 of the record):

Did you test to see whether it would serve the purpose of gum arabic?

He answered:

No, sir; I didn't test it for that. I tested to see whether it would respond to the tests, assuming it to be gum arabic solution, and it did.

Q. (By General Appraiser Brown.) In what way did you test?—A. It didn't give a blue color with iodine and it yielded a precipitate with a borax solution, and yielded a precipitate with a solution of lead acetate, which are the marks by which we determine.

Now, these tests only go to show the presence of arabin in the gum, and show that it is a mixture of gum arabic with something else—bassorin or other gums. They hardly indicate, in the absence of a quantitative analysis, that the mixture here found could be considered gum arabic in a commercial or practical sense.

Dr. Rusby further explained that the use of pure gum arabic is for making mucilage and as an excipient in the preparation of medicines. He did not claim that Exhibit 1 would pass as a mucilage made from gum arabic, but, on the contrary, stated that it would pass as a mucilage made from a mixture of gum arabic and something else, and he further said (p. 65):

I don't think that would make a good mucilage.

He further said he did not have experience enough to say whether it would be commercial gum arabic.

Dr. Knight's testimony seems to be based entirely upon chemical tests which showed the presence of arabin. This is not conclusive in our opinion, because arabin is contained in some proportion in a great many other gums besides gum arabic, namely, senegal, cherry, tragacanth, bassora. See Ure's Dictionary of Arts and Manufactures under the title of "Gum."

As against this, the weight of the testimony is clearly to the effect that, to be a commercial gum arabic, it must be readily and easily soluble in a small quantity of water, much more so than this gum; that in commerce the lowest grades of gum arabic sell for about 9 cents per pound, while the mixture of bassorin gums run about 5 to 5½ cents per pound, the gum here in question being invoiced at 5½ cents.

So taking the record as a whole, on the basis of the physical and chemical tests upon which the classification has been made, we hold on this record that by a fair preponderance of evidence the importer has overcome the presumption in favor of the action of the classifying officer, thus explained and limited by the testimony itself.

The protest is therefore sustained, except as to the claim for 5 per cent discount, which was not supported by evidence, and as to this claim the protest is overruled.

Under Ab. 39109, Ab. 39267, and Ab. 39298, merchandise of similar or identical character was held entitled to free entry.

NOTE.—Following T. D. 36548 of July 3, 1916, gums not medicinal and not specifically provided for have been held dutiable at 10 per cent ad valorem as raw or unmanufactured articles not enumerated or provided for (par. 385). Importations of the kind referred to in the above abstracts would presumably be included.

CAMPHOR, NATURAL AND SYNTHETIC.

SUMMARY.

Description.—Camphor is a definite chemical compound derived by distillation from the wood and other parts of the camphor tree. The act of 1913 recognizes the following classifications:

Crude camphor: This material is obtained by the first distillation of the camphor wood. It contains camphor oil and certain other impurities.

Refined camphor: This is produced by distillation from crude camphor.

Synthetic camphor: This is a chemical compound produced by various manufacturing processes, usually from pinene, the chief constituent of turpentine oil.

Camphor is used chiefly in the manufacture of celluloid and allied products. Considerable amounts are also used in pharmacy and medicine.

Domestic production.—The camphor tree is not native to the United States, but was introduced into Florida and other southern localities about 1875. During the latter part of the nineteenth century the United States Department of Agriculture distributed seed and young trees of camphor throughout the Southern and Southwestern States. These were chiefly grown as ornamentals for shade trees and hedges. Investigation of the camphor possibilities in this country dates from 1904. The high prices reached by camphor in 1907 stimulated a considerable interest in the growing of the camphor tree in Florida, Texas, and California. The present commercial center of the American camphor industry is Putnam County, Fla. In 1916 production is given as 8,000 pounds. The camphor tree grows well on sandy soils where it is not subjected to severe drought. The interior of Florida has been chiefly exploited for camphor growing and is probably the best location for the tree in the United States.

American methods of production differ widely from those formerly practiced in Formosa and Japan. In this country the twig clippings and leaves of young trees are gathered annually in such a manner as not to permanently injure the tree. Special mechanical devices for gathering and distillation have been developed. While the camphor production in the United States is said to offer considerable promise, production is yet and probably will remain for some years insignificant as compared with imports.

American camphor refining is an extensive industry localized chiefly in the neighborhood of New York and Philadelphia. Camphor oil, obtained as a by-product of refining, is commercially important in the manufacture of perfumes. Synthetic camphor was at one time (about 1907) rather extensively produced in the United States. The decline in the price of camphor and the rise in prices

of turpentine and other materials used in manufacture caused the disappearance of American synthetic camphor from the market several years ago. In recent years, however, the production of synthetic camphor was again established in the United States.

Foreign production.—Camphor is chiefly produced in Formosa where the industry has been extensively conducted by the Japanese since their conquest of the island in 1895. Since 1899 the Formosan and Japanese camphor industry has been in the hands of a monopoly controlled by the Japanese Government. This monopoly has introduced new methods of production, prevented wasteful destruction of camphor trees, and obtained control of the Japanese camphor refining as well as the distillation of pure camphor. The annual exports of Japanese camphor in recent years have been estimated at between 5,000,000 and 9,000,000 pounds, of which about one-half is furnished by Formosa. In recent years the Japanese camphor monopoly has exercised its control over imports by cutting down the amount of crude camphor put on the market and increasing in a measure exports of refined camphor. Camphor is also produced for commerce in China. In this country, however, wasteful methods of production have greatly decreased camphor forests and a consequent diminution of exports. The camphor tree has also been introduced into subtropical countries, especially India, Java, and southern Europe. At present, however, none of these are of commercial importance in the production of camphor. Important centers of camphor refining outside Japan and Formosa are Germany, and, to a less extent, India. Synthetic camphor was formerly extensively manufactured in Germany. In recent years, like the American synthetic product, it has dropped from trade.

Imports.—American imports of *crude camphor* for the years 1909–1913 averaged 2,875,396 pounds, valued at $861,029. For the years 1915–1918, during which period the previously free commodity paid a duty of 1 cent per pound, an average annual amount of 4,658,483 pounds, valued at $1,427,311, is reported.

Refined camphor.—Imports of refined camphor for the period 1909–1913 averaged 425,403 pounds, valued at $148,112. For the period 1915–1918, 2,281,035 pounds and $996,145 are reported annually.

Insignificant imports of synthetic camphor are reported only in 1915–1917.

Revenue.—Crude camphor, since the imposition of duty in 1913, has paid an average annual revenue of $41,548. For this period refined camphor has yielded an average revenue of $98,681. For the period 1909–1913 the latter commodity yielded (at 6 cents per pound) an average revenue of $25,112.

Prices.—Import values of crude camphor for the period 1909–1918 have varied between 26.2 cents per pound and 39.9 cents. During this period the refined product has varied between 32.2 cents and 69 cents. A large number of grades and varieties of camphor, chiefly dependent upon size of package or tablet, are quoted on the New York wholesale drug market. For the period 1912–1918 a representative grade of American refined camphor varied from 41 cents per pound to 90 cents. In this period American refined camphor is quoted. Slightly higher prices are usually quoted for Japanese refined camphor. Crude camphor is not quoted in the Oil, Paint, and

Drug Reporter which has been used as a source of commercial information on prices.

Tariff history.—The act of 1913 contains the following provision:

36. Gum * * * camphor, crude, natural, 1 cent per pound; camphor, refined and synthetic, 5 cents per pound.

In previous acts since 1883 crude camphor has been admitted free while refined camphor has been dutiable at from 4 to 6 cents per pound save in the camphor prior to 1909 was held dutiable, in accordance with its purity as compared with natural crude or refined camphor.

General Information.

DESCRIPTION.

Camphor is a dextro-rotatory ketone obtained from *Cinnamomum camphora* (Linné). The chief sources of supply are Formosa, Japan, China, Florida. *Synthetic camphor*, an optical isomer (inactive) of camphor, is manufactured from oil of turpentine.

"Camphor," in its original meaning, was a general term used to designate various solid substances which separate from volatile oils upon cooling. The term camphor also has a somewhat more specific general meaning, inclusive of the alcohols and ketones of terpenes, usually of a solid nature, which occur associated with volatile oils in plants. They are grouped by Thorpe (see bibliography) in four groups, as isomerides or homologues of (1) peppermint camphor or menthol, (2) Borneo camphor or borneol, (3) common or laurel camphor, and (4) thyme camphor or thymol. Menthol and thymol will be treated separately, but borneol and its homologues may be briefly discussed here.

Borneo, Malayan, Borus, or Dryobalanops camphor, borneol or camphol, is derived chiefly from *Dryobalanops aromatica* Gärtn, an extremely large tree found in Borneo, Sumatra, Labuan, and the Malay Peninsula. Borneol occurs in fissures in the wood; yield per tree varies from none to 11 pounds. While this product has not frequently entered American trade, it has been in considerable demand in the Orient. Owing to extensive collection, with consequent destruction of the trees, the *Dryobalanops* forests of Sumatra have been virtually ruined, and the supplies elsewhere much depleted. This form of borneol is dextro-rotatory. It is also a constituent of rosemary oil, Spanish lavender oil, and a few others; it, and its laevo isomer, may be formed by the action of reducing agents on common camphor, as a product of the distillation of amber with potash, and by various synthetic means. In its general characteristics it is also very similar to common camphor. In its physiological action it is nearly identical with this substance. Its odor, however, is somewhat different. It is chiefly consumed in native funeral rites in the localities where it occurs; some is also exported to China, where it is said to be valued at from 30 to 90 times the price of common camphor. In China it is used for embalming purposes.

Ngai camphor, chiefly laevo-borneol, is obtained by distillation of the weed *Blumea balsamifera* (Fam. *Compositae*) in the Himalayas; it is refined in Canton and exported thence at the rate of about 10,000 pounds annually. It resembles borneol very closely. Laevo-

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borneol is also contained in a number of volatile oils, among which those of valerian and of various species of *Abies* may be mentioned.

Isoborneol, optically inactive, is an intermediate product in the manufacture of synthetic camphor, and will be referred to again.

The homologues of borneol are rather numerous, but of little commercial interest.

Homologues of common camphor.—Among these may be mentioned matico camphor, from matico (*Piper angustifolium*, fam. *Piperaceae*), cubeb camphor, from the old fruit of *Piper cubeba*, Patchouli camphor, from *Pegostemon heyneanus*, and sandalwood camphor, from sandalwood, *Santalum album*. All these are obtained from the volatile oil of the different plants.

Camphors from plants other than *Cinnamomum camphora*. Camphor is a constituent of the volatile oils of lavendar, rosemary, and spike; also, to the extent of 25–40 per cent, of the oil of black sage (*Ramona stachyoides*), a common plant of southern California, also of the oil of swamp bay (*Persea pubescens*) of the Atlantic coast. A laevo camphor occurs in a few oils of no special importance, and isomerides of camphor are of rather widespread occurrence.

As *adulterants of camphor*, artificial camphor (*pinene hydrochlorid*), stearic acid, borax, starch, and other substances occur.

PRODUCTION AND TRADE.

The camphor of commerce is a product of a large, handsome evergreen tree; the camphor tree, or camphor laurel, closely allied to the species which furnishes cinnamon. It is indigenous to Formosa, China, and Japan, whence come the chief supplies of camphor, and has been introduced for the sake of its product into Florida, German East Africa, Ceylon, and elsewhere, and chiefly as a shade tree in almost all warm climates.

Formosan and Japanese camphor.—Formosa furnishes the great bulk of commercial camphor. Prior to 1895 Formosa was Chinese territory. Owing to the unscrupulous methods of the camphor dealers and the head-hunting proclivities of the inhabitants of the interior of the island, the industry had declined to small proportions. Following the Chino-Japanese War Formosa passed into the hands of the Japanese; in 1899 the Japanese Government took over the camphor industry of the island, and instituted vigourous measures for the reorganization of the trade. The camphor forests of the interior, while apparently inexhaustible, had been wastefully handled by the collectors, and the savage islanders had prevented access to a large portion of their area. The Japanese established a large police force for the protection of the industry, stopped in large measure the needlessly destructive practices which had been in vogue, instituted more modern methods for obtaining and purifying camphor, and established a system of replanting. In 1903 the scope of the Japanese monopoly was extended to Japan proper; camphor here is produced on the islands of Kiusiu, Shikoku, and in Nippon up to the thirty-sixth parallel of north latitude. Under the Japanese system trees under 50 years of age are considered unfit for camphor production. The trees, which vary greatly in camphor content, are marked in the forest by an expert and cut, after which the lower part of the trunk and roots, in the form of chips, are steamed in roughly built portable

stills or iron vessels. The camphor, which is driven off with the steam, is condensed in wooden or earthen vessels. The very primitive apparatus employed has little to recommend it save its portability and cheapness—both of which present certain advantages in the unsettled state of the Formosan interior. It is doubtless only a question of time before much more economical methods will be used, if they have not already been introduced.

The crude product contains a variable proportion of camphor oil, and impurities such as water, sand, iron, wood, etc. Most of the oil may be drained off, and the resulting product is "crude" or "grade B" camphor. This is exported as such, or is purified on a large scale in the Government works at Taikoku, Formosa, and sold as "refined" or "grade A" camphor. The refining process consists in distilling off the oil and water and in purifying the remaining camphor by sublimation. The refined product is formed into blocks by hydraulic presses. The by-product, camphor oil, is used in large quantities in the Orient and has also been exported to Europe and America in considerable quantities.

Under the terms of the camphor monopoly, the Japanese Government licenses producers of camphor and camphor oil, and are required to keep strict account of their manufactures and to sell all camphor products to the Government at a fixed price. The refining of crude camphor is the exclusive right of the State. The Government reserves the right to restrict production. The camphor is now sold by monopoly direct to a single agency—Samuel Samuels, of London, with branches at New York, Hamburg, and probably elsewhere. Conflicting statements are found as to the extent to which the Japanese Government fixes the selling price, but its ability to do so is evidently chiefly limited by the competition of synthetic camphor and the exactions which the celluloid market will bear, as the production of natural camphor outside Japanese control has not normally reached large proportions.

According to a statement in Consular and Trade Reports (2899, 1907), the monopoly at that time paid $20 to $26 for 100 kilos of crude camphor, and delivered it in Germany for $109. This apparently large profit was no doubt considerably reduced by the expense of military protection in Formosa and by the cost of road building and other items which are said to be considerable. According to Schimmel's Report (April, 1914), the operations of the camphor monopoly had been generally disappointing; the annual revenue received by it had fallen off since 1906–7 (1,163,826 yen) to 114,914 yen in 1913–14.

The annual output of the Japanese camphor monopoly about a decade ago (1907–1911) varied between approximately 5,586,000 pounds and 8,379,000 pounds, of which about five-sixths is furnished by Formosa. The output of oil is about 15 per cent in excess of this.

In the years 1900–1909 some 11,500,000 camphor trees were planted within Japanese territories. (Eaton, p. 6, see bibliography.) Statistics of planting since 1909 have not been seen, but nearly half the number given were planted in that year and plans had been made to continue systematic planting on a scale of about 750,000 per year. A portion of these young trees are to be managed according to the method presently to be described under American camphor.

In normal times Germany and the United States, taking about equal amounts, are the largest importers of Japanese camphor; Great Britain and France each take a somewhat smaller amount; British India imports large amounts, both for consumption and reexport.

Chinese camphor.—The camphor tree is found in the coast provinces of China from Shanghai to Cochin China. Camphor has been chiefly produced along the Min River in the Province of Fukien. Chinese camphor has been an article of commerce for centuries, but, since the acquisition of Formosa by the Japanese, it has been important at only one period. During the earlier years of the monopoly much interest was shown in Chinese camphor as a competitive product; the camphor resources of Fukien were ruthlessly exploited by Japanese, British, and Chinese interests. According to Eaton and Wiesner, Chinese exports rose from 717,000 pounds in 1905 to 3,219,000 pounds in 1907, and fell rapidly and steadily to 346,000 pounds in 1912. The increase was coincident with high prices forced by the Japanese monopoly, and the decrease with the lowering of price by that interest and the introduction of synthetic camphor, but the latter was doubtless influenced largely by the virtual extinction of commercial camphor trees in Fukien. Here they occurred not in forests as in Formosa but scattered about the country, mostly in villages; it was estimated in 1907 (Consular and Trade Reports No. 2920) that the supply would last four or five years. That this estimate was well justified is shown by the fact that the exports of Foochow and other ports of Fukien, declined from 2,620,000 pounds in 1907 to 26,600 pounds in 1912. Fukien camphor went from local ports chiefly via Hongkong to America and Europe. Since 1909 Shanghai has been the chief port of export.

Chinese production methods are similar to the early Japanese, but even more primitive. The chopped camphor wood is boiled in water till the camphor adheres to the stirring stick, when the liquid is drained off and cooled, and the deposited mixture containing camphor is purified by sublimation. Only old trees are used. Their rapid destruction in Fukien led to the imposition of taxes of about 57 cents per 100 pounds of camphor, and 28 cents per 100 pounds of oil. These taxes, it was calculated, would produce about $8,300 to $11,450 per year, which sum was to be expended in planting and cultivating new trees. While it was planned to plant five young trees for every old one cut, it is questionable how far the project was carried out; at all events, under the old oriental system of management, these would not come into use for 50 years.

No information of value has been found regarding the production of Chinese camphor outside Fukien and its immediate environs.

East India camphor.—In recent years experimental plantings of camphor have been made in Ceylon and in the Federated Malay States, by British Government agencies and by private individuals. These are, thus far, of little commercial importance, but the prospects of the industry are said to be good. The camphor tree is easily established from seed and root cuttings, and thrives in certain types of soil which are unfitted for ordinary agricultural operations. About 1,000 acres were under camphor in Ceylon in 1908, and about 1,700 pounds of camphor exported. In these localities the young trees are

clipped, and the clippings distilled, as in America. Estimated yields are 170 pounds of camphor per acre per year.

The camphor tree has also been introduced into Java and other islands of the South Seas.

American camphor.—The date of the introduction of the camphor tree into America is uncertain, but is probably prior to 1875. About 1880 the United States Department of Agriculture distributed seed and young trees. Camphor trees were first planted in the Southern and Southwestern States as ornamental shade trees or as hedges and windbreaks. Investigation of the camphor possibilities of the tree in the United States dates from 1904. Material was distilled chiefly in Florida, Texas, and California. About 1907 camphor reached its highest price—$1.24 per pound for the product refined in America—and this stimulated interest in American production.

The method of utilization of the camphor tree in America is quite different from that chiefly practiced in the Orient. Instead of the wood of the 50-year old tree, twig clipping and leaves of trees 5 or 6 years old and older are distilled with steam. Shearing is annual, at the end of the growing season, and, if properly carried out, does not injure the tree. A special mechanical contrivance, consisting of huge mechanically operated shears, mounted on a power truck upon which the clippings fall, may be used. These clippings are quite variable in oil and camphor content, and experiments in selective breeding are being carried out. From 1 to 1.25 per cent of the green weight of the mass is probably a good average, and amounts to 175 to 200 pounds of camphor per acre.

Distillation may be carried out in any of the ordinary types of stills used for volatile oils, but, owing to the rapid solidification of the camphor, special condensers must be employed.

The camphor tree grows well on rather barren sandy soils. While it has been grown as far north as South Carolina, severe frosts are fatal to it. Localities whose minimum winter temperature goes below 20° F. are unsuited for commercial production. The interior of Florida probably offers the best field for American camphor production.

In recent years several organizations have planted commercial areas of camphor trees, chiefly in Putnam County, Fla. The largest firm had, in 1917, a plantation of 2,500 acres, and the 1916 production is given as 80,000 pounds (Oil, Paint, and Drug Reporter, Feb. 26, 1917, p. 18). Another company has announced its intention of setting out 11,000 acres within five years.

Florida camphor growing has been the object in recent years of some advertising of a more or less questionable type; it is, thus far, an enterprise requiring considerable capital. About 500 acres is the smallest amount which can be handled economically, and this requires expensive distilling machinery, as thus far there appears to be no custom stills or markets for clippings.

African camphor.—The camphor tree has been introduced in a number of African localities, among which German East Africa, Madagascar, Egypt, the Gold Coast, and Ny[illegible] mentioned. These are still in an early stage, and [illegible]estate, one [illegible] information concerning their scope is available. [illegible] in German East Africa, begun experimentally under the auspices of the

German Government, appears to be of most importance. Prior to the war a few small shipments of camphor from this source had been received at Hamburg.

Camphor in other localities.—The camphor tree has been introduced chiefly for ornamental purposes, in numerous localities where climatic conditions are suited. It has been grown for a long period in southern Europe—Portugal, Spain, France, and Italy. Giglioli, whose monograph, "La Canfora Italiana," is probably the most extensive review of the subject of Camphor, considers Italy and Sardinia especially suited for camphor production, but apparently no commercial quantities are produced there. Among other localities where the tree has been reported to thrive may be mentioned Madeira, the Canaries, Jamaica, Brazil, Argentina, and Australia.

Refined camphor.—Camphor refining, as carried on by the Japanese monopoly, has already been briefly referred to. Formerly camphor was refined for the monopoly by private works in Japan, but in recent years a large refining establishment under the management of the monopoly has been built at Taikoku, Formosa, and this work is now chiefly done there. The industry is also carried on on a large scale in America, chiefly in New York and Philadelphia, and in Europe, especially in Germany, and in India.

Crude camphor, as received from the still, varies in composition; the American product usually contains 75–80 per cent camphor, about 15–20 per cent camphor oil, and water, oxids and sulphids of iron from the still, etc. The oil is partly removed by crystallization of the camphor at low temperature, by washing with water, by hydraulic pressure, by centrifuging, crystallization from petroleum reagents, or by distilling at low heat. The remaining crude camphor is purified by sublimation, in Europe usually in glass retorts and in America from flat iron pans, holding about 12 pounds. In these the camphor is heated with a varying small amount of charcoal, lime, or iron filings, according to the quality of the material. These pans are heated slowly for 2 hours, and then raised rapidly to 190° C. and held at this temperature for 12 to 16 hours. The sublimed camphor is caught on iron covers.

Synthetic camphor.—The great demand for camphor, incident to the development of the celluloid industry, stimulated numerous researches looking to the synthesis of the product, and many processes have been proposed and have found more or less commercial application. All agree in starting with oil of turpentine, or, more exactly, with pinene, which forms about 70 per cent of this substance. The product, synthetic camphor, is identical in characteristics with the natural except that it is optically inactive, i. e., synthetic camphor does not rotate the plane of polarized light, whereas the natural product rotates it to the right, and is therefore spoken of as dextrorotatory. This difference, in the case of camphor, is of consequence only in its drug use, as the Pharmacopœia, by specifying dextrorotatory camphor, includes the natural product only. Synthetic camphor, if properly purified, may be used in any of the technical applications from seed oral product.

Another co[illegible]e unfitt[illegible] which should be carefully distinguished from this is so-called artificial camphor, pinene hydrochlorid, a solid product formed by treatment of oil of turpentine by dry hydrochloric acid. This product has a camphorlike odor but is unsuit-

able for the majority of the purposes for which natural and synthetic camphor are used. It is of importance only as an intermediate product in some of the processes for the manufacture of synthetic camphor.

Two chief methods, both of which have numerous modifications, have been proposed for the synthesis of camphor, Pinene—$C_{10}H_{16}$—by a molecular rearrangement and the addition of oxygen, becomes camphor—$C_{10}H_{16}O$. Two chief methods of bringing about this oxidation are:

(1) Camphene, isomeric with pinene, is formed from pinene hydrochlorid by treatment of the latter with alcoholic potash or distillation over lime. The camphene is oxidized with nitric acid or other oxidizing agent.

(2) Isoborneol ($C_{10}H_{17}OH$) is formed from pinene by treatment of oil of turpentine with various organic acids; this is oxidized to camphor in various ways.

The first method, or modifications of it by which isoborneol is formed from camphene, appear to have been the most successful. The production of camphene from pinene hydrochlorid is attended by some little difficulty and a number of methods beside those given above have been tried. The lime method has been largely used in Germany. In a French method isoborneol is derived from pinene hydrochlorid by treatment with lead acetate: the isoborneol is suspended in benzol and oxidized by means of potassium permanganate.

The chief American method thus far reported consists in the treatment of oil of turpentine with anhydrous oxalic acid: the resulting mixture, consisting of borneol, bornyl oxalate, and bornyl formate and various waste products, is saponified with lime and distilled with steam. Borneol and camphor are separated from the distillate, and the borneol further oxidized to camphor. This process was operated for about two years by the Port Chester Chemical Co. of New York, but has now been abandoned. A large proportion of by-products were formed, and the yield of camphor was insufficient for commercial success.

Synthetic camphor, as a commercial commodity, attracted chief attention in the first years of the century, at which time camphor was constantly rising in price. Shortly after 1907, when the high mark of camphor prices was reached and passed it had disappeared from commerce. In recent years the production of synthetic camphor has been established in the United States.

USES OF CAMPHOR.

It has been estimated that about 70 per cent of the world's supply of camphor is used in the manufacture of celluloid, which, especially in America, is an industry of extremely rapid growth. As waste celluloid, camphor enters into the composition of artificial leather, varnishes, billiard balls, phonograph records, and a wide variety of other articles.

Camphor was one of the ingredients of ballistite, one of the earlier, if not one of the first, of smokeless powders, presumably to reduce its sensitiveness. Its use in ballistite was found to be disadvantageous and it was soon discontinued. While camphor is often said to be an important ingredient of smokeless powders, the statement has been

specifically denied by several authorities, it is now practically obsolete in this connection.

As a drug, camphor (the refined, natural product) is official in all pharmacopœias. Its medicinal use is very old, and it has been used empirically in many connections in which it is now obsolete. It is a favorite oriental remedy. In occidental medicine camphor is used chiefly for five purposes: (1) As a circulatory stimulant, in heart depression, especially of the type which occurs in late stages of infectious fevers; (2) as a nerve sedative, in hysteria, epilepsy, convulsions, etc.; modern authorities consider its use in these ailments irrational; (3) in treatment of diarrheas, often in connection with opium; (4) as a local stimulant or counterirritant, usually in the form of camphorated oil, in throat diseases, etc.; and (5) to diminish secretions.

Monobromated camphor, the only official derivative, is used occasionally in nervous irritation and in insomnia. It is also a common ingredient of headache powders, combined with coal-tar products and caffeine.

The official preparations of camphor are some 35 in number. Of chief interest are camphor water, camphor liniment or camphorated oil, spirits of camphor, and the camphorated tincture of opium, or paregoric.

Camphor is of use as a moth and insect repellant in the storage of clothing, museum specimens, etc.; although naphthalene, cedar products, and pyrethrum are now more commonly used in this connection.

Camphor is occasionally used in pyrotechnics, in tooth powders, in embalming, and in lacquers.

Camphor oil, the principal by-product of the camphor industry, is similar to camphor in its medicinal properties, but is rarely used medicinally in Europe and America. It is an important commercial article; in America it is employed in the manufacture of "artificial oil of sassafras" and in Europe in the preparation of "safrol," both of which have important technical applications in the manufacture of cheap disinfectants and in perfumery.

The wood of the camphor tree is valuable for cabinetmaking; it is repellant to insects.

WAR CONDITIONS.

The first years of the war had no important effect on camphor prices. Early in 1917 the price rose sharply, stimulating heavy buying by the celluloid interests; the rise was followed by a period of lower prices. Another sharp rise was experienced in the early months of 1918, and in May the price of refined camphor had nearly reached the high level of 1907. This rise is attributed to shipping shortage, overland freight difficulties, and the rumored intention of the Japanese monopoly to cut down or cut off shipments.

While total shipments have increased from year to year during the war (except that 1917 showed a slight decrease from 1916), the proportion of refined camphor to the total imports has shown a significant increase. In 1914 refined camphor formed 23.2 per cent of the total imports; percentages for 1915, 1916, and 1917 are 24.5, 34.8, and 36, respectively. This may be traced in part at least to the establishment of a refinery owned by the monopoly, which has

been previously referred to. This in its turn is doubtless an instance of the general trend of Japan from a producer of raw materials to a manufacturing nation. An editorial in the Oil, Paint, and Drug Reporter of April 15, 1918, reported that export allotments of crude Formosan camphor for April, May, and June, of 1918, had been cut to approximately one-half the usual amount received in a similar period. The proposed action of the monopoly in regard to refined camphor had not at that time been announced.

Camphor production in Japan and Formosa for the year ending March 31, 1918, was 10,701,128 pounds, of which 10,383,666 pounds were sold through the National Camphor Monopoly Bureau.

COMPETITIVE CONDITIONS.

The culture of camphor in the United States has been shown to be commercially feasible on a fairly large scale in Florida, but the enterprise seems unlikely in the immediate future to reach a size which will seriously compete with foreign production. The widespread interest which was noted in camphor production about 1907 has somewhat subsided with the fall in price of the article, but experiments are still being carried out in many quarters, as noted under "General Information." The chief advantages of Florida would appear to be comparative nearness to market, the use of machinery instead of hand labor, and of modern types of distilling and condensing apparatus. Japanese competitors, however, are fully capable of introducing more modern mechanical methods when it appears to their advantage to do so.

To counterbalance the advantage of cheap labor, the Japanese have to contend with the opposition of the savage inhabitants of Formosa, the lack of roads in and the jungle-like character of the interior of the island, and the climatic and sanitary conditions, which have been reported to disable one-third of the coolie labor employed. At the height of production (1907) it was reported (Consular and Trade Reports, 2899) that the wages paid the coolies (equivalent to 40 cents per day) were twice that of other pursuits. In 1910 a publication of the Bureau of Manufactures (see bibliography) gave the wages of natives as 90 cents per day; of Japanese, $2, on a piece-work basis. At that time 14 companies were engaged in Formosa: employing 24,803 natives and 4,776 Japanese.

Provision has apparently been made for sufficient reforestation to counterbalance the annual cut in Formosa and Japan. Recent information (Schimmel's report, April, 1913) would seem to indicate that Formosan forests are much smaller and the Chinese productive area considerably larger than has generally been believed, but reports of this sort have in the past been conflicting and of doubtful value.

With regard to the by-products of the industry, the oil obtained by the American method of utilizing the twigs and leaves is said to differ from the Japanese in containing much less safrol, which is its most valuable ingredient.

The preparation of camphor from American plants—black sage and swamp bay—has as yet been only experimental. Both plants occur in considerable quantities, the former in southern California and the latter in the swamps of the southern Atlantic Coast States. The high cineol (eucalyptol) content of the oils of both (20–30 per

cent) should be important in this connection. Cineol is usually priced higher than camphor. The black sage yields about 0.75–0.90 per cent of oil, of which 25–40 per cent is camphor, and the swamp bay about 0.2 per cent, of which about 21 per cent is camphor.

The refining of camphor does not call for an elaborate type of machinery or for expensive reagents; labor and fuel would appear to be the chief costs. There is comparatively little waste of material, as the oil, which forms the principal removed product, is merchantable, though at a much lower price than camphor.

In view of the scarcity and increasing cost of turpentine and of the unsatisfactory yield of the processes thus far employed, the production of synthetic camphor has been discontinued by a number of American and foreign firms that formerly produced considerable amounts.

The demand for camphor is naturally contingent upon the celluloid industry. Owing to the inflammability and other disadvantages of this substance, researches are constantly being carried on in search of acceptable substitutes. Reports of the discovery of substances of this sort are frequently current, but as yet these articles have not seriously disturbed the celluloid market. Recently the manufacture of such a product, "satolite," has been begun in Japan. The basic substances are soy beans and formalin. (Commerce Reports, Sept. 22, 1916; Drug and Chemical Markets, Dec. 5, 1917.)

Endeavors to substitute camphor in celluloid by casein, begun some years ago, appear not to have been commercially successful.

Exports of camphor from Japan.

Countries.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
British India	603,690	$237,869	760,762	$305,190	858,112	$337,457
United Kingdom	876,898	288,851	876,657	295,157	965,425	324,241
Germany	475,913	160,570	693,676	236,718	652,260	217,103
United States	1,052,360	344,132	938,049	297,284	608,702	194,213
Australia	84,800	30,800	125,674	47,355	100,687	36,210
All other	1,272,050	414,033	1,192,167	383,552	897,076	298,500
Total	4,365,711	1,476,255	4,586,985	1,565,256	4,082,262	1,407,724

Countries.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
British India	1,173,844	$413,641	1,209,312	$410,710	1,789,558	$624,939
United Kingdom	205,709	68,616	503,335	165,694	428,791	141,353
Germany	655,785	212,418	386,313	129,782		
United States	664,748	216,211	1,020,125	346,698	1,380,006	443,439
Australia	151,289	50,798	146,921	51,826	227,135	77,547
All other	452,179	151,737	831,491	279,730	1,346,591	443,579
Total	3,303,554	1,113,421	4,097,407	1,384,440	5,172,081	1,730,757

Exports of camphor from Japan—Continued.

Countries.	1916		1917	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
British India	1,887,583	$776,644	1,442,959	$974,179
United Kingdom	851,967	295,603	193,458	120,134
Germany	.....	.....	.....	.....
United States	3,538,366	1,556,250	1,990,349	1,215,328
Australia	123,442	44,148	149,829	95,055
All other	1,268,540	458,677	382,251	236,774
Total	7,669,898	3,131,322	4,158,846	2,641,470

Camphor, crude and natural—Imports by countries.

FISCAL YEARS.

Imported from—	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
England	77,617	$25,279	26,327	$8,131	1,706	$560
China	612,730	193,301	243,185	64,671	.....	.....
Hongkong	6,809	1,933	10,694	2,774	4	1
Japan	2,325,636	700,208	3,446,113	1,043,010	2,152,936	682,108
All other	3,856	1,205	.....	.....	.....	.....
Total	3,026,648	921,926	3,726,319	1,118,586	2,154,646	682,669

Imported from—	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
England	38,500	$15,932	130	$48	1,055	$411
China	152,551	45,572	[1] 6,675 46,579	[1] 2,207 14,678	32,296	10,544
Hongkong	11,819	3,774	7,871	2,283	.....	.....
Japan	3,274,850	914,064	[1] 1,340,000 2,075,653	[1] 350,274 560,225	3,695,856	992,306
All other	231,544	27,959	.....	.....	.....	.....
Total	3,709,264	1,007,301	3,476,908	929,715	3,729,207	1,003,261

Imported from—	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Portugal	.....	.....	.....	.....	86,400	$42,336
England	.....	.....	11,390	$5,070	.....	.....
China	197,220	$55,455	185,772	57,777	316,926	166,884
Japan	4,377,210	1,180,717	6,687,788	2,038,392	3,235,058	1,241,830
All other	.....	.....	.....	.....	.....	.....
Total	4,574,430	1,236,172	6,884,950	2,101,239	3,638,384	1,451,050

[1] Free under act of 1909; dutiable under act of 1913.

Camphor, crude and natural—Imports by countries—Continued.

CALENDAR YEARS.

Imported from—	1918		1919		1920 [1]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
England			62,364	$24,293		
China	410,632	$217,931	519,888	529,565		
Hongkong			579,601	1,011,294		
Japan	3,063,650	1,329,249	1,531,969	940,414		
Total	3,474,282	1,547,180	2,693,822	2,505,566	3,384,320	$4,780,184

[1] From Jan. 1 to Oct. 31, 1920, inclusive. Not stated by countries.

Camphor, refined and synthetic—Imports by countries.

CALENDAR YEARS.

Imported from—	1918		1919		1920 [1]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
England	5,901	$7,509	199,400	$372,103		
China			20,965	19,481		
Hongkong	40	33	10,544	19,800		
Japan	859,853	726,952	1,873,381	3,364,415		
Canada			15,800	38,865		
All other	81,350	35,388	5,120	15,207		
Total	947,144	769,882	2,125,210	3,829,871	995,459	$2,082,226

[1] From Jan. 1 to Oct. 31, 1920, inclusive. Not stated by countries.

Camphor, crude, natural—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	Free	3,138,397	$1,572,881		$0.501	
1908	do	2,811,358	1,365,287		.485	
1909	do	1,990,499	602,530		.303	
1910	do	3,026,650	921,928		.304	
1911	do	3,726,319	1,118,586		.300	
1912	do	2,155,751	682,748		.317	
1913	do	3,477,760	979,355		.282	
1914	do	1,346,675	352,481		.262	
	1 cent per pound	2,130,233	577,234	$21,302	.271	3.69
1915	do	3,715,387	998,555	37,153	.269	3.72
1916	do	4,674,530	1,268,233	46,745	.277	3.69
1917	do	6,605,630	1,991,408	66,056	.361	3.32
1918	do	3,638,384	1,451,050	36,383	.399	2.51
1919	do	2,622,792	1,389,768	26,228	.529	1.89
Calendar years:						
1918	do	3,474,282	1,547,180	37,483	.447	2.25
1919	do	2,679,320	2,468,884	26,793	.968	1.09
1920 [1]	do	2,490,298	3,733,439	24,903	1.499	.667

[1] Six months.

Camphor, refined and synthetic—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	6 cents per pound.	462,977	$373,137	$27,779	$0.806	7.44
1908	....do....	519,890	322,755	31,193	.621	9 66
1909	....do....	396,226	148,203	23,773	.376	16.04
1910	....do....	492,563	177,174	29,555	.360	16.68
1911	....do....	492,111	165,296	29,526	.336	17.56
1912	....do....	248,359	93,080	14,903	.375	16.01
1913	....do....	463,410	153,020	27,804	.330	18 17
1914	....do....	80,489	26,727	4,829	.332	18 07
	5 cents per pound.	544,019	175,265	27,200	.322	15.52
1915	....do....	1,140,783	406,587	57,039	.356	14.03
1916	....do....	2,304,197	754,498	115,209	.327	15.27
1917[1]	....do....	4,533,918	2,033,177	226,695	.448	11.15
1918	....do....	1,145,244	790,318	57,262	.690	7.25
1919	....do....	1,497,159	1,889,482	74,858	1.262	3.96
Calendar years:						
1918	....do....	1,082,184	863,381	54,109	.797	6.27
1919	....do....	1,809,684	3,079,986	90,484	1.701	2.94
1920[2]	....do....	461,934	1,202,334	23,097	2.603	1.92
Fiscal years:						
1915[3]	....do....	16	3	.....	.187	26.67
1917[3]	....do....	469	174	23	.371	13.48
1920[2 3]	.... do....	116,100	229,238	5,805	1.974	2.503

[1] In 1917 from Cuba, 1,200 pounds, value $780, duty $48, unit value $0.650, equivalent ad valorem 6.15 per cent.
[2] From Jan. 1 to June 30, 1920.
[3] Synthetic refined camphor.

Camphor, monobromated—Prices per pound, wholesale, New York, spot

[Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$0.95–1.05	July, 1916	$3.65–3.75
Apr. 1, 1912	.85– .95	October, 1916	2.80–2.85
July 1, 1912	.85– .95	January, 1917	2.80–2.85
Sept. 30, 1912	.85– .95	April, 1917	2.50–2.60
Dec. 30, 1912	.95–1.05	July, 1917	2.50–2.60
Mar. 29, 1913	1.00–1.10	October, 1917	2.50–2.60
June 30, 1913	1.00–1.10	Dec. 31, 1917	2.50–2.60
Sept. 29, 1913	1.00–1.10	January, 1918	2.50–2.60
Dec. 29, 1913	1.00–1.10	April, 1918	3.25–3.35
Mar. 30, 1914	1.00–1.10	July, 1918	3.75–3.85
June 29, 1914	1.00–1.10	October, 1918	4.25–4.35
August, 1914	1.00–1.10	January, 1919	4.25–4.35
Oct. 1, 1914	1.35–1.50	April, 1919	4.00–4.10
January, 1915	1.30–1.35	July, 1919	3.75–3.80
April, 1915	1.30–1.35	October, 1919	4.25–4.30
July, 1915	1.75–1.85	January, 1920	5.00–5.20
October, 1915	2.50–2.55	April, 1918	5.00–5.20
January, 1916	4.45–4.50	July, 1920	4.00–4.25
April, 1916	4.45–4.50	October, 1920	3.50–3.75

Camphor, Japan refined, 2½-pound slabs—Prices (wholesale) per pound, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912[1]	$0.44½–$0.45½	Oct. 2, 1916	$0.71½–$0.72
Apr. 1, 1912[1]	.46 – .50	Jan. 1, 1917	[2] .88 – .90
July 1, 1912[1]	.44 – .48	Apr. 2, 1917	[2] .90 – .92
Sept. 30, 1912[1]	.43 – .47	July 2, 1917	[2] .80
Dec. 30, 1912[1]	.44 – .47	Oct. 1, 1917	[2] .75
Mar. 31, 1913[1]	.42½– .46	Dec. 31, 1917	.74 – .75
June 30, 1913[1]	.42½– .46	January, 1918	.74 – .75
Sept. 29, 1913[1]	.42½– .46	April, 1918	1.03½
Dec. 29, 1913[1]	.42½– .46	July, 1918	1.08 – 1.11½
Mar. 30, 1914[1]	.42½– .46	October, 1918	2.00
June 29, 1914[1]	.44½– .48	January, 1919	2.40 – 2.50
Sept. 28, 1914[1]	.95 – 1.00	April, 1919	2.50 – 2.75
Dec. 28, 1914[1]	.41½– .43	July, 1919	2.65 – 2.75
Mar. 29, 1915[1]	.40½– .45	October, 1919	3.40 – 3.60
June 28, 1915[1]	.43½– .46½	January, 1920	3.55 – 3.65
Sept. 27, 1915[1]	.42 – .45	April, 1920	2.40 – 2.60
Jan. 3, 1916[1]	.42½	July, 1920	1.45
Apr. 3, 1916[1]	.49 – .53	October, 1920	1.20 – 1.25
July 3, 1916	.50 – .53		

[1] Listed "foreign refined."
[2] Nominal.

Camphor, American refined, barrels, bulk—Prices (wholesale) per pound, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$0.44	Oct. 2, 1916	$0.69½
Apr. 1, 1912	.44	Jan. 1, 1917	.86½
July 1, 1912	.44	Apr. 2, 1917	.89½
Sept. 30, 1912	.44	July 2, 1917	.89½
Dec. 30, 1912	.44	Oct. 1, 1917	.74½
Mar. 31, 1913	.42½	Dec. 31, 1917	.76½
June 30, 1913	.42½	January, 1918	.76½
Sept. 29, 1913	.42½	April, 1918	1.06½
Dec. 29, 1913	.42½	July, 1918	1.11½
Mar. 30, 1914	.42½	October, 1918	1.34½
June 29, 1914	.44½	January, 1919	(1)
Sept. 28, 1914	(1)	April, 1919	2.60
Dec. 28, 1914	.44½	July, 1919	2.65
Mar. 29, 1915	.41	October, 1919	3.30
June 28, 1915	.43	January, 1920	3.30
Sept. 27, 1915	.42	April, 1920	3.20
Jan. 3, 1916	.42	July, 1920	1 55
Apr. 3, 1916	.49	October, 1920	1.40
July 3, 1916	.52		

[1] Nominal.

Camphor, cases of 100 blocks.—Prices (wholesale) per pound, New York, spot.

[Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$0.44	July, 1916	$0.52½
Apr. 1, 1912	.44	October, 1916	.70
July 1, 1912	.44	January, 1917	.87
Sept. 30, 1912	.44	April, 1917	.90
Dec. 30, 1912	.44	July, 1917	.89½
Mar. 29, 1913	.43	October, 1917	.75
June 30, 1913	.43	Dec. 31, 1917	.76½
Sept. 29, 1913	.43	January, 1918	.77
Dec. 29, 1913	.43	April, 1918	1.07
Mar 30, 1914	.43	July, 1918	1.12
June 29, 1914	.45	October, 1918	1.35
August, 1914	.45	January, 1919	(1)
Oct 1, 1914	(1)	April, 1919	2.60½
January, 1915	.45	July, 1919	2.66
April, 1915	.41½	October, 1919	3.31
July, 1915	.43½	January, 1920	3.33
October, 1915	.42½	April, 1920	3.23
January, 1916	.42½	July, 1920	1.58
April, 1916	.49½	October, 1920	1.43

[1] Nominal.

Camphor, squares of 4 ounces.—Prices (wholesale) per pound, New York, spot.

[Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$0.44½	July, 1916	$0.[illegible]
Apr. 1, 1912	.44½	October, 1916	.70½
July 1, 1912	.44½	January, 1917	.87½
Sept. 30, 1912	.44½	April, 1917	.90½
Dec. 30, 1912	.44½	July, 1917	.90½
Mar. 29, 1913	.43½	October, 1917	.75½
June 30, 1913	.43½	Dec. 31, 1917	.77½
Sept. 29, 1913	.43½	January, 1918	.77½
Dec. 29, 1913	.43½	April, 1918	1.07½
Mar. 30, 1914	.43½	July, 1918	1.12½
June 30, 1914	.45½	October, 1918	1.35½
August, 1914	.45½	January, 1919	(1)
Oct. 1, 1914	(1)	April, 1919	
January, 1915	.45	July, 1919	2.66½
April, 1915	.42	October, 1919	3.31½
July, 1915	.44	January, 1920	3.33½
October, 1915	.43	April, 1920	3.23½
January, 1916	.43	July, 1920	1.58½
April, 1916	.50	October, 1920	1.43½

[1] Nominal.

Camphor, 16s, bulk—Prices (wholesale) per pound, New York, spot.

[Oil, Paint, and Drug Reporter.]

April, 1916	$0.55–0.55½	July, 1918	$1.14
July, 1916	.55–.55½	October, 1918	1.37
October, 1916	.72	January, 1919	(1)
January, 1917	.88	April, 1919	2.62½
April, 1917	.92–.94	July, 1919	2.68
July, 1917	.89–.90	October, 1919	3.33
October, 1917	.79	January, 1920	3.35
Dec. 31, 1917	.80	April, 1920	3.25
January, 1918	.80	July, 1920	1.60
April, 1918	1.10	October, 1920	1.45

[1] Nominal.

Camphor, 32s, bulk—Prices (wholesale) per pound, New York, spot.

[Oil, Paint, and Drug Reporter.]

April, 1916	$0.55–0.55½	July, 1918	$1.15
July, 1916	.55–.55½	October, 1918	1.38
October, 1916	.74–.75	January, 1919	(1)
January, 1917	.88½	April, 1919	2.63½
April, 1917	[1].92–.94	July, 1919	2.69
July, 1917	.89–.90	October, 1919	3.35
October, 1917	[1].79	January, 1920	3.39
Dec. 31, 1917	.81	April, 1920	3.29
January, 1918	.81	July, 1920	1.63
April, 1918	1.11	October, 1920	1.48

[1] Nominal.

Camphor, 24s, bulk—Prices (wholesale) per pound, New York, spot.

[Oil, Paint, and Drug Reporter.]

April, 1916	$0.55–0.55½	July, 1918	$1.14½
July, 1916	.55–.55½	October, 1918	1.37½
October, 1916	.72½	January, 1919	(1)
January, 1917	.88½	April, 1919	2.63
April, 1917	.92–.94	July, 1919	2.68½
July, 1917	.89–.90	October, 1919	3.33½
October, 1917	[1].79	January, 1920	3.36½
Dec. 31, 1917	.80½	April, 1920	3.26½
January, 1918	.80½	July, 1920	1.61½
April, 1918	1.10½	October, 1920	1.40½

[1] Nominal.

Camphor—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	15	Camphor, refined	5 cents per pound.
1883	523	Camphor, crude	Free.
1890	15	Camphor, refined	4 cents per pound.
1890	527	Camphor, crude	Free.
1894	10½	Camphor, refined	10 per cent ad valorem.
1894	429	Camphor, crude	Free.
1897	12	Camphor, refined	6 cents per pound.
1897	515	Camphor, crude	Free.
1909	12	Camphor, refined, and synthetic camphor	6 cents per pound.
1909	527	Camphor, crude, natural	Free.
1913	36	Gums * * * camphor, crude, natural	1 cent per pound.
1913	36	Camphor, refined and synthetic	5 cents per pound.

CHICLE.

General Information.

Tariff act of 1913, paragraph 36: "* * *; chicle, crude, 15 cents per pound; refined, or advanced in value by drying, straining, or any other process or treatment whatever beyond that essential to the proper packing, 20 cents per pound; * * *."

Description and uses.—Chicle is the gum obtained by coagulating the milk, or latex, of the tree *Achras sapota*, which is indigenous to Mexico and Central America. The largest quantity of the gum is produced in the southern States of Mexico, particularly Yucatan. The crude gum as it is shipped from Mexico contains a large percentage of water and foreign materials, such as sand, sticks, and leaves. The gum as it leaves Mexico contains about 50 per cent water. Some of the water is lost in transportation, and the crude gum as imported into New York contains around 40 per cent water.

Practically the only use of chicle is in the manufacture of chewing gum. Before ready for manufacture of chewing gum the crude chicle is put through a process which involves grinding, straining, and drying. The chicle is then compounded with flavoring materials and other substances before being cast into the familiar sticks of chewing gum.

Spruce gum has been classed by similitude under the provision for chicle in paragraph 36. This gum is produced in Canada, and northeastern States of this country, from the ordinary spruce trees. It is used to some extent as a substitute for chicle in the manufacture of chewing gum.

Foreign production.—Chicle is produced in Central America and tropical South America. The tree yielding chicle gum grows to a height of from 40 to 50 feet, and has a trunk which is from 35 to 40 inches in diameter. Each tree yields, on an average, 30 to 35 pounds of chicle a year. The trees are tapped throughout the year with the exception of the rainy period, which lasts from three to four months. The tree requires a good loamy soil and a rainfall of about 90 inches.

The milky juice obtained from the tree rapidly darkens and hardens when exposed to the air. It is then heated in a vessel until the milk has coagulated into a compact mass. In this chunky condition the crude chicle gum is exported in jute bags from Mexico, chiefly to the United States and Canada.

Imports into the United States.—Prior to 1913 the total imports of chicle were about 7,000,000 pounds, valued at between $2,500,000 and $3,000,000. From July 1 to October 3, 1913 (1914, fiscal year), they amounted to about 8,000,000 pounds. This increased importation in the short period was undoubtedly due to the proposed increase in the duty on chicle under the tariff act of 1913. Imports during the remainder of the 1914 fiscal year were only about 1,500,000 pounds. During the two years following imports were therefore somewhat below normal because of the abnormal importation in 1914. However, they soon reached normal and in 1919 (calendar year) amounted to over 8,000,000 pounds with a value of about $5,500,000.

A large portion of the imports into the United States has been by way of Canada. For example, from 1910 to 1913, inclusive, between 55 and 75 per cent of the total import of chicle was credited to Canada. The quantity reaching the United States directly from Mexico was much smaller. It is generally known that crude chicle was imported to New York in bond and shipped to Toronto, where it was ground, dried, and cleaned, and then exported to the United States as refined chicle. This is also quite evident from the difference in the unit value of chicle imported from Mexico and Canada, that coming from the latter country being much higher in value than the chicle coming from Mexico. This was practiced in order to avoid a considerable portion of duty levied on chicle imported into the United States. As crude chicle shipped from Mexico contains 40 to 50 per cent water, it is evident by first importing it into Canada at a low rate of duty (present Canadian duty is 7½ per cent ad valorem) and there evaporating the water and then importing into the United States, a saving of about 40 per cent in duty is made possible.

Prior to the act of 1913 no distinction was made between crude chicle and refined chicle, both being dutiable at 10 cents per pound. The act of 1913 made crude chicle dutiable at 15 cents per pound, while chicle refined or advanced in value was dutiable at 20 cents per pound. This change in duty, however, did not immediately change the practice of shipping a considerable portion of the chicle to Canada and reshipping the dried product to the United States, as is shown by the imports for 1914 to 1918, inclusive. During the calendar year 1919 imports from Canada were only 600,000 pounds. Under present duties in Canada and the United States it is apparently as cheap or cheaper to import the crude chicle rather than to dry the crude in Canada and import the dried product into this country. The fact that the practice was not immediately discontinued after the passage of the act of 1913 may be explained by the time necessary to erect plants and install equipment for drying in this country.

Domestic exports of chewing gum.—Chewing gum is a preparation of a gum resin, usually chicle, to which flavoring, sweetening, and coloring agents have been added. Prior to the war the export of chewing gum from the United States was valued at less than $200,000 annually. It may be said that the chewing-gum habit was restricted to America.

War restrictions on the use of sugar in confectionery did not apply to chewing gum, the sugar content of which is small. This was one of the leading factors in increased European sales, as the sweetness and flavor of the gum partly satisfied the craving for sugar. Gum chewing became popular during the war in munitions factories of the United Kingdom and also in the trenches in France. It was supplied by the United States Government in large quantities to American troops, as it lessens the desire for water on forced marches.

These factors are reflected in a steady increase in exports from $281,433 in 1915 to over $2,000,000 in the calendar year 1919. The United Kingdom is the principal consumer and took over $800,000 in 1919, which was a decrease of about $300,000 from the previous year. Exports in 1919 to other principal consumers were about $400,000 to France, over $200,000 to the Philippines, and $110,000 to Belgium.

As Canada is the only other country where the manufacture of chewing gum is established on any considerable scale, the develop-

ment of foreign markets offers large possibilities to domestic manufacturers.

Tariff history and considerations.—Chicle was first mentioned in the act of 1897 and was dutiable at 10 cents per pound. This same duty was also in force under the act of 1909. In the act of 1913 crude chicle was made dutiable at 15 cents per pound, while "chicle, refined or advanced in value by drying," etc., was made dutiable at 20 cents per pound. As crude chicle contains, as imported, about 40 per cent of water, it is evident that specific duties to bear evenly on the chicle content of both the crude and dried or refined grades should have a wider spread than is provided for in the act of 1913. For example, if crude chicle is dutiable at 15 cents per pound this duty is equivalent to a duty of 25 cents per pound on the chicle content, assuming that crude chicle contains 40 per cent of water. Although the present difference in duty on crude and refined chicle is not in direct proportion to the chicle content, there is apparently no advantage in first shipping the crude chicle to Canada, drying it, and reshipping the dried product to the United States under the present Canadian duty on chicle of 7½ per cent ad valorem (October, 1920).

There is no special tariff problem connected with chicle, as supplies are derived entirely from foreign sources and it does not compete to any extent with domestic gums. The duty on chicle has apparently been for the purpose of raising revenue. Under the act of 1909, with all grades of chicle dutiable at 10 cents per pound, the average annual revenue amounted to between $500,000 and $700,000. The equivalent ad valorem during this period was about 22 per cent. Since the passage of the act of 1913, which made crude chicle dutiable at 15 cents per pound and refined at 20 cents per pound, the revenue derived from both grades has been between $750,000 in 1915 and $1,500,000 in 1917. The equivalent ad valorem from 1914 to 1917, inclusive, when prices compared with those in prewar years, was between 30 and 42 per cent. With increase in prices in 1918 and 1919 the equivalent ad valorem decreased to about 23 per cent in 1919.

It should be pointed out that any specific duty which would apply to both crude and refined or dried chicle would tend to favor the importation of chicle by way of Canada, so long as the Canadian duty on chicle is comparatively low. A specific duty on chicle to bear evenly on the different grades should be in approximate ratio to the actual chicle content.

Chicle—Imports by countries.

FISCAL YEARS.

Imported from—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
British Honduras	828,987	$262,159	968,478	$308,869	649,695	$198,835
Canada	3,741,063	1,573,692	4,853,855	2,369,150	4,332,258	2,137,426
Mexico	2,209,817	708,416	679,295	219,525	2,780,281	781,385
All other	13,954	3,072	6,580	1,542	19,771	9,358
Total	6,793,821	2,547,339	6,508,208	2,899,086	7,782,005	3,127,004

Chicle—Imports by countries—Continued.

FISCAL YEARS—Continued.

Imported from—	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
British Honduras	1,120,360	$328,505	2,115,199	$681,273	1,138,907	$427,932
Canada	8,249,135	3,613,529	2,902,563	1,318,173	2,180,655	1,058,190
Mexico	4,109,925	1,262,689	2,881,647	982,110	2,197,188	733,329
All others	279,172	77,999	141,482	30,902	982,914	240,359
Total	13,758,592	5,282,722	8,040,891	3,012,458	6,499,664	2,459,810

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
British Honduras	712,288	$248,067	1,259,506	$412,592	1,860,808	$815,636
Canada	2,157,933	1,214,963	4,415,849	2,571,441	2,173,927	1,557,808
Mexico	3,525,092	1,143,395	1,580,220	516,230	1,856,491	920,802
All other	956,656	222,759	184,447	38,090	516,867	159,947
Total	7,346,969	2,829,184	7,440,022	3,538,353	6,408,093	3,454,193

CALENDAR YEARS.

Imported from—	1918		1919		1920 [1]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
British Honduras	2,311,935	$1,129,042	2,440,502	$1,648,818	.....	.....
Canada	1,262,079	1,004,945	595,513	735,803	.....	.....
Mexico	2,222,295	1,256,118	4,113,602	3,047,225	.....	.....
Colombia	690,496	278,654	1,777,747	570,864	.....	.....
Venezuela	541,750	138,615	172,077	49,142	.....	.....
All others	222,467	109,730	346,097	165,135	.....	.....
Total	7,251,022	3,917,104	9,445,538	6,216,987	8,161,700	$5,763,913

[1] Ten months ending Oct. 31, 1920. Not stated by countries.

Chicle—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1910	10 cents per pound	4,921,026	$1,939,756	$492,102	$0.394	25.37
1911	do	5,368,566	2,551,344	536,856	.475	21.04
1912	do	5,266,285	2,433,924	526,628	.462	21.64
1913	do	6,920,415	3,059,116	692,041	.442	22.62
1914	do	9,551,616	3,504,428	1,056,470	.367	30.15
1915	do	4,400,160	1,802,201	756,762	.409	41.99
1916	do	5,030,345	2,199,716	869,660	.437	39.53
1917	do	8,360,112	3,837,707	1,450,770	.460	37.80
1918	do	6,608,868	3,550,135	1,092,748	.537	30.78
Calendar years:						
1918	do	6,937,394	3,654,578	1,103,743	.549	29.83
1919	do	8,081,304	5,468,199	1,240,498	.677	22.68
1920 [1]	do	3,590,362	2,699,124	547,433	.751	20.28

[1] Six months ending June 30, 1920.

Chicle—Imports for consumption—Revenue—Continued.

CRUDE.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914	15 cents per pound.	1,080,664	$389,717	$162,099	$0.361	41.59
1915	do	2,465,400	839,312	369,810	.340	44.06
1916	do	2,728,159	915,817	409,223	.336	44.68
1917	do	4,425,019	1,465,873	663,752	.331	45.28
1918	do	4,580,501	2,076,143	687,075	.453	33.09
Calendar years:						
1918	do	5,674,724	2,649,440	851,209	.475	32.13
1919	do	7,515,265	4,769,601	1,127,290	.635	23.63
1920 [1]	do	3,412,793	2,483,015	511,919	.727	20.61

REFINED OR ADVANCED IN VALUE BY DRYING, STRAINING, OR ANY OTHER PROCESS OF TREATMENT BEYOND THAT ESSENTIAL TO PROPER PACKING.

Fiscal years:		*Pounds.*				*Per cent.*
1914	20 cents per pound.	472,766	$214,257	$94,553	$0.453	44.13
1915	do	1,934,760	962,889	386,952	.498	40.19
1916	do	2,302,186	1,283,899	460,437	.558	35.86
1917	do	3,935,093	2,371,834	787,018	.603	33.18
1918	do	2,028,367	1,473,992	405,673	.727	27.52
Calendar years:						
1918	do	1,262,670	1,005,138	252,534	.793	25.12
1919	do	566,039	698,598	113,208	1.27	16.20
1920 [1]	do	177,569	216,109	35,514	1.21	16.42

[1] Six months ending June 30, 1920.

Chewing gum—Domestic exports.

FISCAL YEARS.

Exported to—	1910	1911	1912	1913	1914
United Kingdom	$4,765	$23,148	$90,183	$81,852	$46,538
Canada	9,808	9,979	3,846	2,443	1,142
Australia and Tasmania	3,087	6,111	7,957	23,071	42,510
Panama	7,292	12,176	11,174	15,323	16,450
Philippines	15,964	12,306	21,180	17,492	20,592
All other	12,567	25,409	29,971	46,763	51,398
Total	53,483	89,129	164,311	186,944	178,630

Exported to—	1915	1916	1917	1918
United Kingdom	$93,291	$204,974	$625,682	$1,325,369
France	2,573	40,186	112,531	88,066
Australia	69,615	93,862	52,591	6,778
Panama	17,607	24,765	34,911	41,418
Philippines	25,306	37,927	53,451	136,434
Mexico	4,976	3,089	16,333	24,326
Cuba	18,766	8,979	23,488	37,510
All other	49,299	160,641	165,745	236,234
Total	281,433	574,423	1,084,732	1,896,135

Chewing gum—Domestic exports—Continued.

CALENDAR YEARS.

Exported to—	1918	1919	1920 [1]
Belgium		$109,642	
France	$94,431	395,299	
Norway		51,632	
Sweden		30,689	
United Kingdom	1,119,808	828,494	
Panama	32,580	32,693	
Cuba	27,966	85,749	
China	12,340	38,975	
Philippines	152,291	203,368	
British South Africa	67,936	32,304	
Egypt	22,600	28,789	
All other	165,861	326,656	
Total	1,695,903	2,164,290	$2,040,311

[1] Ten months ending Oct. 31, 1920. Not stated by countries.

Chicle—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897....	30	Chicle	10 cents per pound.
1909....	30	.....do	Do.
1913....	36	* * * chicle, crude	15 cents per pound.
		Refined or advanced in value by drying, straining, or any other process or treatment whatever beyond that essential to the proper packing.	20 cents per pound.

Court and Treasury Decisions.

Chicle ground and dried and commercially known as "desiccated chicle" was held to come within paragraph 36 of the act of 1913 as "chicle * * * advanced in value by * * * treatment * * * beyond that essential to the proper packing" and not within the same paragraph as "chicle, crude." (Sheldon *v.* United States, 8 Ct. Cust. Appls., 9; American Chicle Co. *v.* United States, 9 Ct. Cust. Appls., 1; Abstract 43670.) In the Sheldon case the sap had been drawn from the tree and coagulated by artificial heat into hard chunks in Mexico, shipped to Canada and there ground and dried, the grinding and drying bearing no relation to transportation and being a process in the manufacture of chewing gum known commercially as dessicated chicle. The chicle in the American Chicle Co. case was described as similar to, if not identical with, that in issue in the Sheldon case.

Chicle bruised or hammered into smaller particles and in part resoaked, these processes being related to packing and transportation rather than to manufacture and only slightly enhancing the value—moreover imported intermixed with dirt, barks, sticks, and other foreign substances—was held not to be refined or advanced within the meaning of paragraph 36 of the act of 1913 and dutiable as crude. (United States *v.* American Chicle Co., 10 Ct. Cust. Appls.; T. D. 38153; same, T. D. 38360.)

Spruce gum is classified by similitude in use as chicle under paragraph 36 by virtue of paragraph 386. (T. D. 36854, of 1916.)

Cauchillo gum was also classified either directly or by similitude as chicle. (T. D. 37653.) But gums invoiced as crude gum chicle, chicle, Colombia gum, cauchillo, sande, gum colombiana, goma tousle, crude chicle, goma sande, colombiana, and goma chicle classified as chicle by similitude were later held dutiable at 10 per cent ad valorem under paragraph 36 of the act of 1913 as unenumerated unmanufactured articles. The Board of General Appraisers said that while these articles "can be used, some of them at least, together with other articles and compounds in the manufacture of chewing gum, they can not be used alone as chicle may be, and there is testimony that they are in no way fit for the manufacture of chewing gum." (G. A. 8334, T. D. 38382.) (Appeals pending.)

MISCELLANEOUS.

Analysis of crude Yucatan chicle.[1]

	Per cent.
Acetone soluble resins	40.0
Gutta and hydrocarbons	17.4
Proteins	.6
Sand and foreign matter	2.3
Water	35.0
Mineral ash	4.7

[1] Dannerth, Frederic: Journal of Ind. and Eng. Chem., 1917, p. 679.

DEXTRINE, BRITISH GUM, AND SOLUBLE STARCH.

SUMMARY.

Dextrines are products formed by heating starch either alone or with an acid. They are prepared from all varieties of starch, the most important of which are corn, potato, wheat, rice, and cassava. British gum and burnt starch are commercial names for the yellowish and light-brown dextrines. Soluble starch, which is practically identical with white dextrine, is intermediate between starch and dextrine. The dextrines are used largely as adhesives, in sizing paper and textiles, and in the preparation of gummed labels, envelopes, and postage stamps. As in the case of starch itself, the different varieties of dextrine enjoy certain preferential uses.

The manufacture of dextrine is not a large industry and its output in 1914 was only about 19,000,000 pounds, valued at $700,000. The largest domestic factories are for the dextrine from cornstarch, and its manufacture forms a part of the great corn-products industry. Dextrine from potato starch was previously obtained entirely from Germany and Holland, but is now manufactured in this country from domestic potato starch and from potato starch imported from Japan. The imports of potato dextrine, which averaged about 5,000,000 pounds before the war, are considerably exceeded by the exports of corn dextrine.

The dextrine industry presents two problems for tariff consideration: (1) The adjustment of the differential between the rates of duty on the dextrines and on the various starches from which they are made, and (2) the provision of different rates of duty for the different varieties of dextrine.

In the conversion of starch to dextrine, 80 to 88 parts of dextrine are obtained from 100 parts of starch. In some of the previous tariff acts starch was made dutiable at a higher rate than the dextrine made from it, but the act of 1913 provides a one-fourth cent greater duty on dextrines than on the corresponding starches. The difference in price between starch and the dextrine made from it is usually between 1 and 2 cents.

The two principal varieties of dextrines are made from cornstarch and potato starch and their industries bear very different relations to the tariff. Corn dextrine has long been manufactured in this country in connection with the domestic corn-products industry. The United States imports no corn dextrine and the large exports indicate that the industry can compete successfully in foreign markets. The manufacture of potato dextrine, on the other hand, was established during the war, and at the present time, March, 1920, is supplying a considerable portion of the demands of the domestic market. The industry has been subject to extremely severe competition from the domestic corn dextrine, and with the return to

normal conditions in Europe it is to be expected that Germany and Holland will again turn to America as a market for these by-products of their large and well-established potato-products industries.

Dextrine—Summary table.

	Domestic production.	Imports for consumption.	Domestic export.	Ratio to production.	
				Imports.	Exports.
Fiscal years:	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*
1909	[1] 16,148,931	[2] 6,062,353	(3)	37.6	
1910		6,391,761			
1911		6,357,790			
1912		5,352,277			
1913		5,096,891			
1914	18,913,641	6,684,556	2,258,944	35.3	11.8
1915		4,865,105	10,578,176		
1916		874,988	10,358,880		
1917		243,721	9,440,144		
1918		99,733	2,047,136		
1919		431,871			
Calendar years:					
1918		376,192			
1919		147,642			
1920 [4]		667,182			

[1] Includes all gums other than rosin.
[2] Imports of all varieties of dextrine.
[3] Total exports are not shown in Commerce and Navigation. Exports to Great Britain are taken from official British import statistics.
[4] Six months ending June 30, 1920.

General Information.

The articles discussed in this report are included in the following provisions of the act of 1913:

36. Gums. * * * dextrine, made from potato starch or potato flour, 1½ cents per pound; dextrine, not otherwise provided for, burnt starch or British gum, dextrine substitutes, and soluble or chemically treated starch, three-fourths of 1 cent per pound.

DESCRIPTION.

The language of the preceding paragraph covers a variety of products commercially known as *dextrines* or *soluble starch* and obtained from corn, potato, wheat, cassava, and other forms of starch. These products are not definite chemical compounds but merely intermediate products in the conversion of starch to sugar (glucose). There are no standard specifications for the various dextrines nor are there fixed methods for their manufacture.

Commercial dextrines in general are white, yellow, or even brownish amorphous powders, more or less soluble in water, and forming strongly adhesive solutions. The darker grades are usually more soluble, since the conversion has been carried farther and there is less unchanged starch. An analysis of a typical commercial brown dextrine is given by Bean (The Chemistry and Practice of Sizing, p. 124) to be as follows:

	Per cent.
Dextrine	83.76
Glucose	4.84
Water	11.03
Ash	.37

White dextrine, on the other hand, gives the following typical analysis (T. D. 26011):

	Per cent.
Dextrine	29.29
Soluble starch	52.22
Glucose	5.56
Water	9.70
Ash	.45
Undetermined	2.80

British gum and *burnt starch* are the commercial names usually applied to the yellowish and light-brown dextrines.

Soluble starch represents a stage in the conversion of starch intermediate between starch and dextrine. In other words, it is starch that has been but slightly dextrinized and is practically identical with the so-called white dextrine of commerce.

Chemically pure dextrine can be prepared by carefully converting starch with dilute acid, then neutralizing with an alkali, and finally precipitating the dextrine with alcohol. Pure dextrine is a white, tasteless, and odorless powder.

Some of the various names under which dextrine and soluble starch are sold are as follows: White, "blonde," and canary dextrines, British gum, vegetable gum, starch gum, burnt starch, "Kordex" gommeline, leigomme, and gomme d'Alsace.

USES.

Dextrine has a wide variety of uses, the most important of which are in adhesives, in sizing paper and fabrics, in textile printing and finishing, in the preparation of gummed envelopes, labels, and postage stamps, and as a substitute for gum arabic and tragacanth.

The textile industry is one of the largest consumers of dextrine and offers two general classes of uses, viz, in sizing and finishing. As in the case of starch itself, there are a few preferential uses for the dextrines prepared from the different varieties of starch. Soluble starch can not be used to the same extent in sizing that it can be used in finishing cotton cloth, because it is not as adhesive as starch and less suited for sizing yarn. In textile printing dextrine and soluble starch are used as thickening agents.

The Bureau of Engraving and Printing annually uses about a half million pounds of dextrine for gumming postage stamps and envelopes. Before the war this was entirely cassava, or tapioca dextrine, but during the scarcity of shipping dextrine from cornstarch was used in mixture with cassava dextrine, and satisfactory results are believed to have been obtained. The potato-starch manufacturers claim that potato dextrine will give a light-colored gummed sheet with the same hydroscopic properties, but it appears that the preference has always been for cassava or the cassava-corn mixture.

White dextrine is used in the manufacture of library paste, and before the war imported potato dextrine was preferred, chiefly because of its uniform high quality. Various glues used in paper-box manufacture and in the match industry consist primarily of dextrine. A similar dextrine glue known as "Kordex" is sold to foundries, where it is used to bind together the sand of the cores of castings. Other uses are in preparing felt and in the manufacture of printing inks.

DOMESTIC PRODUCTION.

Importance.—The dextrine industry is not one of large proportions, and before the war the total output was only about 19,000,000 pounds, valued at $700,000. The largest domestic plants are for the manufacture of dextrine from cornstarch, the operating being carried on in connection with the manufacture of the other corn products. Dextrine from potato starch was not manufactured in the United States prior to 1914, but a few manufacturers are now (1920) offering dextrine made from both the domestic and imported potato starch; however, not in quantities comparable with the imports.

Materials.—Starch is the essential material for the manufacture of dextrines and soluble starch. To a certain extent the availability of the various varieties of starch is affected by the tariff and reference should be made to the Tariff Information Survey for Starches (par. 234). Cornstarch is produced in abundance and large quantities are exported annually. On the other hand, the potato starch industry is comparatively small and has always been subject to severe competition both of foreign potato starch and domestic cornstarch. Practically the entire consumption of cassava dextrine is made from imported cassave (tapioca).

The production of starches as given by the Census of Manufactures for 1914 is shown in the following table:

TABLE 1.—*Starch production in the United States, 1909 and 1914.*

	1909		1914	
	Quantity.	Value.	Quantity.	Value.
Starch:	*Pounds.*		*Pounds.*	
Corn	638,825,366	$15,962,916	574,247,697	$13,784,654
Potato	24,873,415	823,019	23,540,472	718,006
Other starches [1]	13,836,866	728,888	22,976,178	1,281,121
Total	677,535,647	17,514,823	620,764,347	15,783,781

[1] Includes wheat, rice, and cassava starch.

During the first six months of 1918, according to War Industries Board Price Bulletin No. 10 (see Bibliography), 46,000,000 pounds of cornstarch, or 9.5 per cent of the total consumption, were used by dextrine makers and founders.

Equipment.—The type of equipment required for dextrine manufacture varies with the method of preparation, but in all cases is fairly simple. When starch is roasted without the addition of acid, the operation is usually carried on in revolving iron drums, which frequently are double-jacketed and containing oil in the outer space in order to insure uniform heating. The drums are sometimes provided with mechanical devices to stir and mix the starch. Heat is applied by means of a free flame or steam under pressure.

Methods of manufacture.—There are three processes for the preparation of dextrine, viz, (1) roasting starch with or without the use of acids, (2) boiling starch in a dilute acid solution, and (3) by the action of diastase on starch. The roasting method is practically the only

one in general use, although the process has been modified in many ways.

In the Heuse process a ton of starch is moistened with 4.4 pounds of nitric acid which has been diluted with about 80 gallons of water. The mass is then made into loaves and dried in air. After grinding to a powder it is placed in a suitable oven and heated with steam under pressure.

In the process in use in Germany prior to the war and described by Hofer (see Bibliography), the starch is converted in a cast-iron kettle provided with an agitator. For 660 pounds of starch, 750 to 900 cubic centimeters of concentrated hydrochloric acid is required. After diluting the acid with twice its volume of water, it is mixed with a small portion of the starch and finally with the entire mass. Steam is admitted at a pressure of one atmosphere for one-half hour and the pressure then increased to two or three atmospheres for the balance of the time, the complete process requiring 2½ to 3 hours.

In the conversion of starch to dextrine about 80 to 88 parts of the finished dextrine are obtained from 100 parts of starch. The usual difference in price between starch and the dextrine obtained from it is between 1 and 2 cents per pound.

History of the industry.—Dextrine was first prepared in 1804 by the French chemist La Grange, who was experimenting with starch meal heated at high temperatures. Seven years later two other chemists, working independently, prepared dextrine from starch by treatment with an acid. These men were Vaucquellin, a Frenchman, and Kirchoff, the German chemist, who had previously discovered glucose. The manufacture of dextrine was first developed commercially in Germany in connection with that country's important potato-products industry. Holland also took up the manufacture of dextrine from potato starch, while in England a variety of dextrine known as British gum was prepared from mixtures of various starches, such as sago, tapioca, cornstarch, and the lower qualities of farina (potato starch). In the United States the principal development has been with the dextrine made from cornstarch, the manufacture of which has been firmly established in this country since 1850. The history of the corn-products industry (see Tariff Information Surveys for Starches, Glucose, Corn Oil, etc.) has been characterized by large-scale production and numerous and successful attempts toward monopolization. The company which was formed at the time of the last consolidation (1906) and has since dominated the corn-products industry has recently been dissolved by a decision rendered in the Government's suit under the antitrust law.

Production and consumption.—The Census of Manufactures gives the following statistics for the production of dextrine in the United States:

TABLE 2.—*Domestic production of dextrine.*

	1904	1909	1914
Dextrines:[1]			
Pounds	6,651,731	16,148,931	18,913,641
Value	$231,708	$610,999	$705,584

[1] Statistics for 1904 and 1909 include "Gums, other than rosin."

Imports during 1914 were over six and one-half million pounds, and it may be assumed that the consumption during that year was in the neighborhood of 25,000,000 pounds.

FOREIGN PRODUCTION.

Before the war potato dextrine was made almost entirely in Germany and Holland. In these countries the manufacture of dextrine forms an important part in the large and firmly established potato-products industries. In Germany in 1911 there were 311 factories engaged in the manufacture of potato products and their output amounted to over a billion pounds, valued at approximately $16,000,000. These figures include dextrine production of 49,310,288 pounds, valued at $1,404,914, and also 3,602,096 pounds of soluble starch, valued at $107,100. Exports of dextrine from Germany for the five-year period 1909–1913 averaged over 25,000,000 pounds and went principally to Great Britain and the United States.

Hofer states that dextrine is manufactured by practically all of the large cloth printing and dyeing works in Germany.

The first potato-starch factory in Holland was started in 1840, and in 1911 there were 32 factories, the majority of which were new and well equipped. Many of these, but not all, manufactured dextrine and glucose from potato starch. In 1914 Holland exported 258,000,000 pounds of potato starch.

In 1913 England imported 10,396,000 pounds of dextrine and exported only 488,700 pounds. During the same year Germany imported 351,193 pounds and exported 25,679,408 pounds.

The cultivation of potatoes for the manufacture of starch was initiated in Japan during the war and a large export trade developed. In 1918 Japan supplied the United States with over 90 per cent of our starch imports. Up to the present time, however, Japan has exported starch rather than dextrine to the United States.

IMPORTS AND EXPORTS.

Before the war the United States imported large quantities of refined potato dextrine from Germany and Holland and considerable quantities from England. The annual imports averaged over 5,000,000 pounds from 1910 to 1914, but dwindled to less than 100,000 pounds in 1918.

In 1914 Germany furnished 86.7 per cent of the imports of potato dextrine and 12.3 per cent came from Holland. Germany also supplied 83.2 per cent of the imports of soluble starch and 17.6 per cent of the burnt starch or British gum. Of the latter commodity 41.9 per cent came from England, and 32.6 per cent from Holland.

Exports of dextrine have never been shown in Commerce and Navigation of the United States. It is known, however, that considerable quantities of corn dextrine are shipped to Europe. The import statistics for Great Britain indicate that the following amounts of dextrine have been received from the United States: 1914, 2,258,944 pounds; 1915, 10,578,176 pounds; 1916, 10,358,880 pounds; 1917, 9,440,144 pounds; and 1918, 2,047,136 pounds.

PRICES.

The trade journals quote prices only for corn and potato dextrine. In August, 1914, imported potato dextrine sold at 6 to 7 cents per pound, domestic potato dextrine at 5½ to 7 cents, British gum at 3⅛ to 3¼ cents, and corn dextrine at 3 to 3½ cents per pound. Since that time prices have risen until in the latter part of 1918 domestic potato dextrine was quoted at 20 cents, the cutting off of imports from Germany and Holland being responsible for this rise. Corn dextrine during this period sold for 8 to 8½ cents. In October, 1920, domestic potato dextrine was quoted at 10 to 11½ cents, imported potato dextrine at 12 to 12¾ cents, and corn dextrine and British gum at about 6½ cents per pound.

TARIFF HISTORY.

Dextrine and British gum were first mentioned specifically in the tariff act of 1883 and were given a duty of 1 cent per pound, which at that time was equivalent to about 25 per cent ad valorem. The rate was increased to 1½ cents in 1890 and to 2 cents in 1897, but was restored to 1½ cents in 1909. The 2-cent duty was equivalent to 50 per cent ad valorem. In the act of 1913 dextrine made from potato starch was dutiable at 1¼ cents per pound and all other dextrines, including soluble and chemically treated starch, were dutiable at three-fourths cent per pound. In 1918 the former rate corresponded to an ad valorem duty of 13.61 per cent and the latter to 7.58 per cent.

TARIFF CONSIDERATIONS AND COMPETITIVE CONDITIONS.

The rates of duty on dextrine involve a twofold consideration, (1) the adjustment of a proper differential between the rates of duty on these products and their raw materials (starches), and (2) the advisability of providing different rates for the different varieties of dextrines.

Dextrine is manufactured from starch, and the duty on dextrine ought logically to bear a definite relation to the duty imposed upon its raw material. In the process of converting starch to dextrine there is a loss of about 20 per cent, but the manufacturers regain a portion of this by increasing the moisture content of the finished product. Two authorities report that 80 to 88 per cent of the weight of the original starch is recovered as the finished dextrine. The difference in price between starch and the dextrine made from it is usually 1 to 2 cents per pound.

In the act of 1890 starch carried a one-half cent greater duty than the dextrine made from it. In 1894 both products were given the same duty, but in the act of 1897 dextrine received a one-half cent greater duty. Potato starch and potato dextrine were dutiable at the same rate in 1909 and all other starches at one-half cent less than the rate for all other dextrines. The act of 1913 allowed a differential of one-fourth cent per pound for dextrines manufactured from all varieties of starch.

Prior to the war little or no potato dextrine was manufactured in this country, and the domestic market was supplied almost entirely by imports from Germany and Holland. When the war interfered

with these foreign supplies the manufacture of potato dextrine from domestic potato starch and from imported starch was started in this country. The development has not been on a large scale, however, and it is hardly expected that the industry will be able immediately to supply the entire demands of the domestic market for potato dextrine.

The variety of dextrine made from cornstarch has long been manufactured in this country in connection with the corn-products industry. Its raw material is present in abundance and in general at a price considerably lower than the other forms of starch. The United States imports no corn dextrine and the large exports would seem to indicate that the domestic industry can compete with other varieties of dextrine abroad as well as at home.

Dextrine—United Kingdom imports and exports.[1]

Year.	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1909	5,998,900	$204,987	284,900	$12,848
1910	9,165,700	309,957	386,000	18,609
1911	8,372,100	283,576	310,700	13,013
1912	7,553,900	277,488	537,100	25,496
1913	10,396,200	344,889	488,700	21,184
1914	10,202,640	313,845	228,592	7,451
1915	19,940,928	752,848	177,520	8,731
1916	14,724,752	725,264	327,152	21,125
1917	10,380,944	882,189	216,048	21,403
1918	3,624,656	574,047	244,944	41,370

[1] Figures from annual statement of the trade of the United Kingdom with foreign countries and British possessions.

Dextrine—Imports and exports for France.[1]

Year.	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1912	813,056	$37,442	159,613	$7,334
1913	497,799	20,844	306,219	12,981
1914	276,457	11,580	187,611	7,913
1916	140,653	14,861	253,749	26,634
1917	2,103,039	415,143	134,040	26,441
1918	926,593	182,578	34,612	6,755

[1] Documents Statistiques Sur Le Commerce De La France.

Germany's imports and exports of dextrine, burnt starch, paste, etc.[1]

Year.	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1909	168,372	$7,616	22,014,033	$817,630
1910	156,747	5,426	30,984,535	1,099,798
1911	187,611	8,092	28,675,453	1,091,944
1912	219,248	9,520	20,396,959	890,596
1913	351,193	14,232	26,679,406	1,093,134

[1] Figures from Vierteljahrshefte zur Statistiks des deutschen Reichs.

Dextrine, dextrine substitutes, soluble starch, chemically treated starch, burnt starch, gum substitutes, or British gum—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1908	2 cents per pound.	3,958,925	$122,870	$79,179.00	$0.031	64.44
1909	....do	6,062,353	184,476	121,247.00	.030	65.73
1910	....do	455,546	13,595	9,110.92	.030	67.00
1910	1½ cents per pound.	5,936,215	183,508	89,043.29	.031	48.52
1911	....do	6,357,790	190,660	95,366.79	.030	50.02
1912	....do	5,352,277	188,332	80,284.24	.035	42.63
1913	....do	5,096,891	180,296	76,453.40	.035	42.40
1914	....do	986,644	32,433	14,799.70	.033	45.03

DEXTRINE MADE FROM POTATO STARCH OR POTATO FLOUR.

Fiscal years:						
1914	1½ cents per pound.	5,226,421	$162,688	$65,230.27	$0.031	40.16
1915	....do	4,590,437	154,087	57,380.00	.034	37.20
1916	....do	720,106	40,552	9,001.00	.056	22.20
1917	....do	210,948	17,832	2,636.00	.084	14.79
1918	....do	99,228	9,116	1,240.00	.092	13.61
1919	....do	431,871	39,533	5,398.00	.091	13.65
Calendar years:						
1918	....do	376,177	35,032	4,702.00	.093	13.42
1919	....do	147,404	13,528	1,842.00	.091	13.54
1920 [1]	....do	590,182	50,336	7,377.00	.088	14.67

DEXTRINE N. S. P. F., DEXTRINE SUBSTITUTES, BURNT STARCH, OR BRITISH GUM.

Fiscal years:						
1914	¾ cent per pound..	471,491	$18,180	$3,536.18	$0.039	19.45
1915	....do	274,668	12,028	2,060.00	.044	17.13
1916	....do	154,882	10,049	1,161.00	.066	11.56
1917	....do	32,773	2,855	245.00	.087	8.61
1918	....do	505	50	3.00	.099	7.58
1919	....do					
Calendar years:						
1918	....do	15	2	.11	.133	5.50
1919	....do	238	54	1.80	.226	3.33
1920 [1]	....do	77,000	6,710	565.00	.087	8.42

[1] First 6 months.

Dextrine, imported potato, prices per pound, wholesale.

[From Oil, Paint, and Drug Reporter.]

1914.	Cents.
August	6 - 7
1915.	
January	10 -12
April	10 -12
July	10 -12
October	10 -12
1916.	
January	10 -12
April	12 -13
July	12 -13
October	12 -13
1917.	
January	12 -13
April	12 -13
July	12 -13
October	12 -13
1918.	
January	18
April	19
July	(1)
October	(1)
1919.	
January	(1)
April	15 -17
July	17 -18
October	15 -16
1920.	
January	14 -14½
April	14 -14½
July	12½-14
October	12 -12½

[1] Nominal.

British gum, prices per pound, wholesale.

[From Oil, Paint, and Drug Reporter.]

1914.	
August	$0.03½ –$0.03½
1915.	
January	.03 – .03½
April	.03½ – .03½
July	.03½ – .03½
October	.03½ – .03½
1916.	
January	.03 – .03½
April	.03½ – .03½
July	.03 5/16 – .03½
October	[2]3.65 – 3.71
1917.	
January	[2]3.85 – 3.91
April	[2]5.20
July	[2]6.30 – 6.39
October	[2]7.55 – 7.64
1918.	
January	[1]
April	[1]
July	[1]
October	[1]
1919.	
January	$0.06 –$0.07
April	.05½ – .06
July	.07½ – .07½
October	[2]6.99 – 7.21
1920.	
January	[2]6.49
April	[2]6.49
July	[2]7.49
October	[2]6.35

[1] Nominal.

[2] Per hundredweight.

Dextrine, domestic potato, prices per pound, wholesale.

[From Oil, Paint, and Drug Reporter.]

	Cents.
1914.	
August	5½– 7
1915.	
January	8 –10
April	8 –10
July	8 –10
October	8 –10
1916.	
January	8 –10
April	8 –10
July	8 –10
October	8 –10
1917.	
January	8 –10
April	12½–16
July	12½
October	12 –12½
1918.	
January	14½
April	16 –16½
July	19½–20½
October	20 –20½
1919.	
January	17½–19
April	15 –17
July	17 –18
October	14½–15½
1920.	
January	13½–14
April	13½–14
July	13 –13½
October	10 –11½

Dextrine, corn, prices per pound, wholesale.

[From Oil, Paint, and Drug Reporter.]

	Cents.
1914.	
August	3 –3½
1915.	
January	4 –5
April	[1]
July	[1]
October	[1]
1916.	
January	5 –7
April	[1]
July	[1]
October	[1]
1917.	
January	6 –7
April	[1]
July	[1]
October	7
1918.	
January	7 –8
April	7½–8½
July	8 –9
October	8 –8½
1919.	
January	6 –7½
April	5½–6
July	7 –7½
October	[2]6.69–6.91
1920.	
January	[2]6.19
April	[2]6.19
July	[2]7.19
October	[2]6.05

[1] Not quoted.

[2] Hundredweight.

Dextrine—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	19	Dextrine, burnt starch, gum substitute or British gum	1 cent per pound.
1890	324	.....do	1½ cents per pound.
1894	233	.....do	Do.
1897	286	.....do	2 cents per pound.
1909	297	Dextrine, dextrine substitutes, soluble starch or chemically treated starch, burnt starch, gum substitute or British gum.	1½ cents per pound.
1913	36	Gums; * * * dextrine, made from potato starch or potato flour.	1½ cents per pound.
1913	36	Dextrine, not otherwise provided for, burnt starch or British gum, dextrine substitutes, and soluble or chemically treated starch.	½ cent per pound.

COURT AND TREASURY DECISIONS.

A starch product commercially known as white dextrine, which is technically neither starch nor dextrine, was held dutiable under paragraph 286 of the act of 1897 as "dextrine" and not under paragraph 285 as "starch." (Morningstar *v.* United States, 159 Fed.. 287, of 1907.)

Chemically treated potato starch in part soluble in hot water and known as soluble starch, although a portion of it is insoluble, was held dutiable under the provision in this paragraph for "soluble or chemically treated starch" and not under paragraph 234 as "starch made from potatoes." (G. A. 7633, T. D. 34906, of 1914.)

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INKS AND INK POWDER.

Inks, writing and copying—Summary table.

Year.	Domestic production.	Imports for consumption.	Ratio to production—imports.	Value (imports for consumption).	Amount of duty.	Equivalent ad valorem rate.
			Per cent.			*Per cent.*
1910	[1] $2,505,000	$19,416	0.07	$19,416	$4,854	25.00
1911		20,368		20,368	5,092	25.00
1912		27,550		27,550	6,887	25.00
1913		28,518		28,518	7,129	25.00
1914	2,784,000	18,941	.07	18,941	3,201	16.93
1915		22,765		22,765	3,415	15.00
1916		21,931		21,931	3,290	15.00
1917		26,400		26,400	3,960	15.00
1918		11,962		11,962	1,794	15.00

[1] "Inks, writing." [2] "Inks, writing and copying."

Inks, printers'—Summary table.

Year.	Domestic production.	Imports for consumption.	Domestic exports.	Ratio to production.		Value (imports for consumption).	Amount of duty.	Equivalent ad valorem rate.
				Imports.	Exports.			
				Per cent.	*Per cent.*			*Per cent.*
1910	$8,865,000	[2] $4,787	$325,744	0.05	3.6	$4,787	$1,197	25.00
1911		2,279	406,672			2,279	570	25.00
1912		3,890	409,722			3,890	972	25.00
1913		7,820	439,955			7,820	1,955	25.00
1914	13,830,000	24,999	443,377	.01	3.2	24,999	3,901	15.60
1915		15,022	384,847			15,022	2,253	15.00
1916		17,884	682,165			17,884	2,683	15.00
1917		19,026	751,411			19,026	2,854	15.00
1918		4,685	882,062			4,685	703	15.00

GENERAL INFORMATION.

Description and uses.—Ink is defined as a fluid or viscous material, of various colors, but generally black, used for writing and printing. Writing inks or writing fluids, other than black and blue, are composed of a coal-tar dye and a gum such as gum arabic dissolved in water. In writing ink used for fountain pens the gum is generally omitted entirely. The dye from which such a writing fluid or ink could be made by the addition of water may be called an ink powder. The dye may be in the form of a powder or a binder may be added and it is then pressed into a tablet form. Printing and lithographing inks other than black or blue are composed of a color lake or pigment derived from a coal-tar dye, ground in a vehicle consisting chiefly of linseed oil to which has been added such other ingredients as rosin oil, a dryer, a thinner, soap, and other materials. Black writing inks are usually composed of a tannate of iron and a gum dissolved in water. Blue writing inks are usually composed of a mineral pigment such as Prussian blue which has been chemically treated to make it soluble, dissolved in water and oxalic acid. Some blue inks contain coal-tar dyes as the coloring agent. Ink powders or ink

tablets may be used for purposes other than in writing fluids as artist's colors or other products where color is required.

Production.—The production of writing inks in the United States in 1914 amounted to over $2,500,000. About $14,000,000 worth of printing and lithographing inks were produced during the same year, according to the official census figures.

Imports.—The average annual import of writing inks for the period 1910–1918 was valued $21,983, yielding a revenue of $4,402, and the average annual import for printer's ink for the same period was valued at $11,155, yielding a revenue to the Government of $1,899. The imports of writing and printing inks in 1914 were less than one-tenth of 1 per cent of the domestic production reported for that year.

Exports.—The average annual export of printing ink for the period 1910–1918 was valued at $525,106, and the average export of all other inks for the same period was valued at $242,418.

Interpretation and comments.—The coal-tar dyes in powder or tablet form containing a gum used in the manufacture of writing inks or fluids are suitable for dyeing textiles as the presence of the gum does not prevent such use. The Tariff Commission has already pointed out that it seems desirable to include the phrase "ink powders" in Group III, Title V, of the act of September 8, 1916, where it will be qualified by the phrase "when obtained, derived, or manufactured in whole or in part from any of the products provided for in Groups I or II." Printing and lithographing inks could not be used for any other purpose than that which they are intended, and since these substances are substantially different in character than writing inks it would seem desirable to include them in a class other than that provided for writing inks.

Ink, writing—Production in United States.

[From "Federal Census," 1914, Table 223, Abstract of Census.]

OFFICIAL SOURCE.

	Value.
1899	$1,293,000
1904	1,881,000
1909	2,505,000
1914	2,784,000

OTHER SOURCES.

New York	$892,000
Missouri	67,000
Pennsylvania	62,000
California	7,000
All other States	1,756,000
Total	2,784,000

Ink, printing—Production in United States.

[From "Federal Census," 1914, Table 223, Abstract of Census.]

OFFICIAL SOURCE.

1899	$3,080,000
1904	5,774,000
1909	8,865,000
1914	13,830,000

OTHER SOURCES.

New York	$6,170,000
Ohio	2,764,000
New Jersey	2,095,000
Pennsylvania	1,052,000
Illinois	504,000
All other States	1,245,000
Total	13,830,000

Printer's ink—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1909	25 per cent		$3,701	$925		25
1910	do		4,787	1,196		25
1911	do		2,278	569		25
1912	do		3,889	972		25
1913	do		7,820	1,955		25
1914 [1]	do		1,511	377		25
1914 [2]	15 per cent		23,488	3,523		15
1915	do		15,022	2,253		15
1916	do		17,884	2,682		15
1917	do		19,026	2,853		15
1918	do		4,685	702		15
1919	do		665	100		15

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Writing and copying ink—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1910	25 per cent		$19,416	$4,854		25
1911	do		20,368	5,092		25
1912	do		27,550	6,887		25
1913	do		28,518	7,129		25
1914 [1]	do		3,605	901		25
1914 [2]	15 per cent		15,336	2,300		15
1915	do		22,765	3,414		15
1916	do		21,931	3,289		15
1917	do		26,400	3,960		15
1918	do		11,962	1,794		15
1919	do		15,615	2,342		15

[1] July 1 to Oct. 3, 1913—act of 1909. [2] Oct. 4, 1913, to June 30, 1914—act of 1913.

All other ink, including ink powders—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1909	25 per cent		$42,895	$10,723		25.00
1910	do		20,162	5,040		25.00
1911	do		18,371	4,592		25.00
1912	do		3,817	954		25.00
1913	do		4,918	1,229		25.00
1914 [1]	do		800	200		25.00
1914 [2]	15 per cent		6,131	919		15.00
1915	do		6,196	929		15.00
1916	do		3,481	522		15.00
1917	do		5,095	764		15.00
1918	do		8,529	1,279		15.00
1919	do		7,129	1,069		15.00

[1] Act of 1909, July 1 to Oct. 3, 1913. [2] Act of 1913, Oct. 4, 1913, to June 30, 1914.

Ink, all other—Domestic exports (fiscal years).

Exported to—	1909	1910	1911	1912	1913	1914
Europe	$51,576	$70,244	$86,073	$69,468	$55,526	$55,694
North America	89,245	85,073	87,548	91,192	92,561	70,661
South America	8,743	12,763	19,869	24,642	23,905	20,292
Asia	10,220	7,577	8,128	11,153	12,794	8,855
Oceania	13,527	16,113	32,146	33,400	28,056	24,675
Africa	824	1,092	1,598	1,244	1,490	1,520
Total	174,135	192,862	235,362	231,099	214,332	181,697

Ink, all other—Domestic exports (fiscal years).

Exported to—	1915	1916	1917	1918
Europe	$40,012	$63,549	$61,631	$35,486
North America	54,786	108,038	145,010	196,418
South America	23,539	51,849	79,637	103,647
Asia	11,601	26,572	43,328	34,966
Oceania	23,323	31,708	44,817	31,344
Africa	1,613	3,561	3,023	5,232
Total	154,874	285,277	377,446	407,093

Ink, printer's—Domestic exports (fiscal years).

Exported to—	1909	1910	1911	1912	1913	1914
Europe	$56,224	$63,198	$80,413	$99,507	$89,225	$94,301
North America	103,531	138,672	130,662	166,489	163,846	170,657
South America	37,408	33,346	48,797	50,616	57,180	50,101
Asia	68,034	50,648	90,053	38,431	72,494	63,691
Oceania	39,733	39,172	55,737	53,773	55,842	64,274
Africa	224	708	1,010	906	1,368	353
Total	305,154	325,744	406,672	409,722	439,955	443,377

Ink, printer's—Domestic exports (fiscal years).

Exported to—	1915	1916	1917	1918
Europe	$50,324	$71,900	$41,091	$42,832
North America	137,568	191,354	230,054	256,937
South America	54,964	182,877	297,317	297,600
Asia	68,738	154,235	111,460	170,424
Oceania	72,055	77,097	66,437	108,029
Africa	1,213	4,702	5,052	6,240
Total	384,847	682,165	751,411	882,062

Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	456	Inks of all kinds and ink powders	30 per cent ad valorem.
1890	30	Ink and ink powders, printer's ink, and all other ink not specially provided for in this act.	Do.
1894	21	.....do	25 per cent ad valorem.
1909	26	Ink and ink powders	Do.
1913	37	.....do	15 per cent ad valorem.

IODINE AND IODINE COMPOUNDS.

General Information.

DESCRIPTION AND USES.

Tariff act of 1913.—Paragraph 38, "Iodoform and potassium iodide, 15 cents per pound." Paragraph 515, "Iodine, crude, or resublimed." (Free list.)

Iodine is a solid nonmetallic element with a grayish or purplish black color and a metallic luster. It volatilizes slowly in the air at ordinary temperatures, more rapidly when heated, giving off violet-colored vapors with an odor resembling chlorine. Iodine does not occur free in nature, but its salts are widely distributed but in small amounts. They are always present in sea water and are found in many mineral springs. The commercial sources of iodine are from the Chilean saltpeter deposits and from the ashes of many sea plants.

Iodine is largely used in medicine in the form of its salts, many of which are official in the United States Pharmacopœia. The most important is potassium iodide. Other salts of importance include sodium iodide, ammonium iodide, arsenious iodide, mercuric iodide, iron iodide, and strontium iodide, all of which are official in the United States Pharmacopœia.

A rough estimate of the uses of crude iodine is as follows: Potassium iodide, 75 per cent; sodium iodide, 7½ per cent; resublimed iodine, 7½ per cent; all other compounds, 10 per cent.

Iodoform is a lemon-yellow solid, occurring either as a powder or in small crystals. It has a persistent, disagreeable, and penetrating odor. Its principal use is medicinal, as an antiseptic dressing, and is also used internally to some extent. The methods of preparation of iodoform depend on the interaction of iodine with alcohol or acetone in the presence of an alkali or alkaline carbonate. When these materials are mixed with water and heated slightly the iodoform is obtained as a precipitate and separated from the solution by filtration.

Potassium iodide, the most important salt of iodine, is obtained in white, colorless crystals, which are very soluble in water. It is used in medicine and in photography where it finds use in the preparation of some sensitizing solutions for plates and films. It is also an important reagent in analytical chemistry.

Sodium iodide has the same uses as potassium iodide. However, it does not crystallize as well as the potassium salt, and therefore it is not so easily purified.

Ammonium iodide has the same uses as potassium iodide, its principal use being in photography.

Other compounds of iodine used in medicine are the iodides of iron, arsenic, mercury, strontium, and thymol iodide.

FOREIGN PRODUCTION.

Iodine industry in Chile.—Chile is the largest producer of iodine, which is obtained as a by-product of the Chilean nitrate industry. Caliche, the crude nitrate-bearing earth, contains 200 to 450 grams (0.44 to 1 pound) of iodine per ton. The iodine is in the form of a soluble salt (sodium iodate), which is leached from the caliche along with the sodium nitrate (Chile saltpeter) and is concentrated in the mother liquor when the nitrate is crystallized out, the final mother liquor containing about 8 grams per liter of iodine. Part of the original iodine is carried into the commercial nitrate, which may contain up to 250 grams (about one-half pound) per ton. Although the total annual quantity of iodine in the caliche treated is over 5,000 tons, the actual iodine production before the war was about 500 tons and the maximum since then was about 1,500 tons in 1916. It is evident that Chile could increase her present output of iodine from three to four times if conditions required it.

Exports and revenue.—The exports of iodine from Chile from 1909 to 1914, inclusive, have been fairly constant and have averaged about 1,000,000 pounds a year. Since then they have been between 1,500,000 pounds in 1915 and 3,000,000 pounds in 1916. The United States is one of the largest consumers of Chilean iodine.

Chile levies an export duty on iodine which amounts to about $0.21 per pound. Although this duty does not raise nearly so large a revenue as produced by nitrate of soda, the revenue produced by iodine since 1909 has never been less than $200,000 and in 1916, the year of maximum exportation, yielded about $600,000 or about 1 per cent of the total revenue of Chile.

Methods of extracting iodine.—The mother liquor from sodium nitrate manufacture contains the iodine in solution as sodium iodate. This solution is treated with sulphurous acid or sodium bisulphite (usually the latter) which liberates the iodine. The iodine being insoluble in the solution is precipitated and recovered by filtration in the form of filter-press cakes. The precipitation is carried out in wooden or tin-sheet tanks. The iodine is either sold in the crude form or is purified by sublimation.

The sodium bisulphite necessary for the process is prepared locally. Sulphur dioxide, made by burning sulphur found associated with the nitrate deposits, is passed into a solution of soda ash; the soda ash is obtained by heating nitrate of soda with coal.

Other countries.—The other commercial source of iodine is from the ash of seaweed or kelp. The output from this source, however, is not nearly so large as the by-product source from Chilean saltpeter. Most of the iodine made from kelp is produced in Scotland, France, Norway, and Japan. The method varies somewhat, but in general is as follows:

The seaweed after drying is burned and the ash thus obtained is lixiviated with water, which dissolves the soluble salts, including the iodides. This solution is then concentrated by evaporation until most of the salts other than the iodides have crystallized out of the solution; the iodine in the form of chiefly sodium iodide remains in the mother liquor. This liquor is then treated with a sufficient quantity of sulphuric acid and manganese dioxide and the mixture is heated. The iodine distills over and is condensed and collected in

the crude form or it may be resublimed, which process produces a very pure iodine.

The production of iodine in Japan increased three times from 1913 to 1917 or from 152,566 pounds to 484,138 pounds. Although production figures are not available in other foreign countries, it is likely that Japan now ranks second to Chile, with a production of iodine about one-fourth that of Chile. In 1917 Japan also produced 222,150 pounds of potassium iodide, the most important salt of iodine.

DOMESTIC PRODUCTION.

Prior to the war little or no iodine was produced in the United States. During the war it is reported that a small quantity of iodine was obtained on the Pacific coast as a by-product of the manufacture of potash salts and acetone from kelp. These plants were erected to supply the large demand for acetone during the war and have since been discontinued, so that it may be said that there is no domestic iodine industry in so far as the production of crude iodine is concerned.

The Geological Survey reported that in 1918 there was produced in the United States 521,678 pounds of potassium iodide (from imported iodine) the most important iodine salt. Of this quantity 481,301 pounds were sold for $1,587,656. This output was from eight manufacturers.

IMPORTS INTO THE UNITED STATES.

The entire consumption of iodine in the United States is imported, chiefly from Chile. The imports have been almost entirely of the crude grade, the purification by resublimation being carried out in this country.

The imports have been sporadic, probably due to imports in one year exceeding the domestic consumption, with the result that the next year imports were considerably below the consumption. The maximum importation of crude iodine since 1910 was 1,726,903 pounds in 1917 and the minimum 210,440 pounds in 1911. The average annual import for 10 years, 1910 to 1919, was about 700,000 pounds.

The imports of resublimed iodine have been negligible; the maximum was 15,250 pounds in 1918.

Practically the entire import has come from Chile, until in 1918 Japan supplied 20 per cent of the total, or about 50,000 pounds.

PRICES.

From the last half of 1912 to October, 1915, the price of resublimed iodine was $3 and $3.75 per pound. Since October, 1915, the price has been fairly constant at $4.25 per pound, with the exception of the last three quarters of 1917, when the price was $3.50 per pound. The price of the iodine compounds follow closely the price trend of resublimed iodine from which they are made. The prices prevailing during the first three quarters of 1920 were $4.10 to $4.35 for resublimed iodine, $4.85 to $5.35 for iodoform, $3.10 to $3.35 for potassium iodine, $3.65 to $3.90 for sodium iodine, and $4.65 for ammonium iodine.

TARIFF HISTORY AND CONSIDERATIONS.

Crude iodine was mentioned on the free list of the act of 1883, and has been free of duty under all subsequent tariff acts. Resublimed iodine was free of duty under the acts of 1894 and 1913. It was dutiable at 40 cents per pound under the act of 1883, 30 cents under the act of 1890, and 20 cents under the acts of 1897 and 1909. The duty on iodoform has gradually been lowered from $2 per pound under the act of 1883 to 15 cents per pound under the act of 1913.

Hydriodate, iodide, and iodate of potash were dutiable at 50 cents per pound under the acts of 1883 and 1890 and at 25 cents under the acts of 1894, 1897, and 1909. In the act of 1913 potassium iodide only was specified, at a duty of 15 cents per pound. Hydriodate is an obsolete name for the iodide, and iodate of potash is a comparatively unimportant iodine compound. They might well be omitted in future tariff acts.

Potassium iodide.—In 1918 figures from the United States Geological Survey gave actual production as 521,678 pounds, sales of 481,301 pounds, valued at $1,587,656.

Exports of iodine from Chile.[1]

Year.	Pounds.	Revenue from export duty.	Per cent of total revenue of Chile.	Year.	Pounds.	Revenue from export duty.	Per cent of total revenue of Chile.
1900	719,515	$147,766	0.39	1910	1,300,604	265,397	0.46
1901	624,498	128,606	.38	1911	1,014,522	205,938	.34
1902	570,643	113,424	.34	1912	1,027,502	216,048	.33
1903	880,760	158,260	.39	1913	963,346	202,558	.30
1904	1,026,387	201,986	.51	1914	1,077,944	226,654	.50
1905	1,261,155	251,062	.58	1915	1,562,748	328,591	.79
1906	902,766	161,339	.33	1916	2,916,981	613,339	.99
1907	572,671	122,334	.23	1917	1,674,297	403,419	.51
1908	790,909	142,545	.31	1918	2,001,036	453,148	.50
1909	1,101,330	216,218	.44				

[1] Compiled and converted from Caliche, Organo del Instituto Cientifico e Industrial del Salitre, Santiago, Chile, August, 1919.

Production of iodine and potassium iodide in Japan.

	Iodine.	Potassium iodide.
	Pounds.	*Pounds.*
1909	76,773	153,457
1913	152,566	158,234
1917	484,138	222,150

Iodine, crude or resublimed—Imports by countries (fiscal years).

Imported from—	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Europe—Italy			9	$18		
South America—Chile	12,910	$25,705	771,074	1,501,018	210,440	$418,762
Total	12,910	25,705	771,083	1,501,036	210,440	418,762

Imported from—	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Europe—Italy					26	$98
South America—Chile	497,793	$962,981	351,236	$739,734	195,030	433,293
All others					31	107
Total	497,793	962,981	351,236	739,734	195,087	433,498

Imported from—	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
South America—Chile	629,975	$1,280,255	1,044,415	$2,447,434	1,726,723	$4,380,818
Asia—Japan	1,500	4,044			2,810	9,587
All others	38	103	110	330		
Total	631,513	1,284,402	1,044,525	2,447,764	1,729,533	4,390,405

Imported from—	1918	
	Quantity.	Value.
	Pounds.	
Chile	200,448	$416,774
Japan	53,092	134,127
Panama	14,741	29,637
Total	268,281	580,538

Iodine, crude—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	Free	529,080	$1,085,586		$2.05	
1908	do	175,929	342,777		1.95	
1909	do	12,910	25,705		1.99	
1910	do	771,083	1,501,036		1.95	
1911	do	210,440	418,762		1.99	
1912	do	497,793	962,981		1.93	
1913	do	351,256	739,734		2.11	
1914	do	230,391	533,447		2.32	
1915	do	631,510	1,284,395		2.03	
1916	do	1,044,525	2,447,764		2.34	
1917	do	1,726,903	4,381,317		2.53	
1918	do	253,031	538,799		2.12	
1919	do	1,212,290	2,443,569		2.02	

Iodine, resublimed—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	20 cents per pound.	246	$561	$49	$2.28	8.77
1908	....do....	5	15	1	3.00	6.66
1909	....do....	51	110	10	2.16	9.29
1910	....do....	7	24	1	3.43	5.83
1911	....do....	27	76	5	2.81	7.10
1912	....do....	30	111	6	3.70	5.41
1913	....do....	40	96	8	2.40	8.33
1914	Free	57	205	....	3.60	....
1915	....do....	3	7	....	2.33	....
1916	....do....	....	....	....	....	....
1917	....do....	2,610	9,088	....	3.48	....
1918	....do....	15,250	41,739	....	2.73	....
1919	....do....	6,525	22,657	....	3.47	....

Iodoform—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	$1 per pound	40	$121	$40	$3.02	33.06
1909	....do....	3	12	3	3.64	27.08
1910	....do....	....	3	....	....	....
1910	75 cents per pound.	31	97	23	3.13	23.97
1911	....do....	33	111	24	3.36	22.30
1912	....do....	17	49	12	2.88	26.02
1913	....do....	16	57	12	3.56	21.05
1914	....do....	11	55	8	5.00	15.00
1914	15 cents per pound.	75	246	11	3.26	4.60
1915	....do....	10	40	1	4.00	3.75
1918	....do....	1	4	....	4.00	....

Hydriodate, iodide, and iodate of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	25 cents per pound.	142	$275	$35	$1.94	12.91
1911	....do....	272	519	68	1.91	13.10
1912	....do....	238	451	59	1.90	13.19
1913	....do....	120	239	30	1.99	12.55

Potassium iodide—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	15 cents per pound.	162	$491	$24	$3.03	4.96
1915	....do....	4	13	....	3.25	....
1916	....do....	309	1,032	46	3.34	4.49
1917	....do....	24,357	58,752	3,653	2.41	6.22
1918	....do....	65,992	133,611	9,898	2.02	7.41

[From Oil, Paint, and Drug Reporter.]

Kinds or grades.	Iodine resublimed.	Iodoform.	Iodide potassium.	Iodide sodium.	Iodide ammonium.
January, 1912	$2.60–2.65	$2.95–3.00	$2.10–2.15	.....	.....
April, 1912	2.60–2.65	2.95–3.00	2.10–2.15	.....	.....
July, 1912	3.05–3.10	3.40–3.45	2.40–2.45	.....	.....
October, 1912	3.05–3.10	3.60–3.65	2.60–2.65	.....	.....
January, 1913	3.05–3.10	3.60–3.65	2.60–2.65	.....	.....
April, 1913	3.05–3.10	3.60–3.65	2.60–2.65	.....	.....
July, 1913	3.05–3.10	3.60–3.65	2.60–2.65	.....	.....
October, 1913	3.55–3.60	4.00–4.05	2.95–3.00	.....	.....
January, 1914	3.55–3.60	4.00–4.05	2.95–3.00	.....	.....
April, 1914	3.55–3.60	4.00–4.05	2.95–3.00	.....	.....
July, 1914	3.55–3.60	4.00–4.05	2.95–3.00	.....	.....
October, 1914	3.75–3.80	4.20–4.25	3.15–3.20	.....	.....
January, 1915	3.75–3.80	4.20–4.25	3.15–3.20	$3.50–3.55	.....
April, 1915	3.75–3.80	4.20–4.25	3.15–3.20	3.50–3.55	$3.95
July, 1915	3.75–3.80	4.20–4.25	3.15–3.20	3.50–3.55	3.95
October, 1915	4.25–4.30	4.60–4.65	3.70–3.75	3.50–3.55	4.15–4.20
January, 1916	4.25–4.30	4.60–4.65	3.70–3.75	3.50–3.55	4.15–4.20
April, 1916	4.25–4.30	5.00–5.05	4.30–4.35	3.50–3.55	4.15–4.20
July, 1916	4.25–4.30	5.00–5.05	3.90–3.95	3.50–3.55	4.15–4 20
October, 1916	4.25–4.30	5 00–5.05	3.75–3.80	3.50–3.55	4.15–4.20
January, 1917	4.25–4.30	5 00–5.05	3 50–3.54	3.50–3.55	4.15–4.20
April, 1917	3.50	4.25–4.30	2.90–2.95	3.40–3.45	3.50–3.55
July, 1917	3.50	4.25–4.30	2.90–2.95	3.40–3.45	3.50–3.55
October, 1917	3.50–3.75	4.25–4.30	2.90–2.95	3.40–3.45	3.50–3.55
January, 1918	4.25–4.30	5.00	3.70–3.80	3.90–3.95	4.15–4.20
April, 1918	4.25–4.30	5.00–5.05	3 75–3.80	3.90–3.95	4.15–4.20
July, 1918	4.25–4.30	5.00–5.05	3.75–3.80	3.90–3.95	4.15–4.20
October, 1918	4.25–4.30	5.00	3.75–3.80	3.90–3.95	4.15–4.20
January, 1919	4.25–4 30	5.00	3.50	3.90–3.95	4.15–4.20
April, 1919	4.25–4.30	4.90–5.00	3.30–3.50	3.90–3.95	4.15–4.20
July, 1919	4.25–4.30	5.00–5.10	3.30	3.90–3.95	4.15–4.20
October, 1919	4.50–4.55	5.25–5.30	3.55	4.05–4.10	4.85–4.90
January, 1920	4.10–4.15	4.85–4.90	3.35–3.40	3.65–3.70	4.65–4.70
April, 1920	4.35–4.40	4.85–4.90	3.10–3.15	3.65–3.70	4.65–4.70
July, 1920	4.35–4.40	5.35–5.40	3.35–3.40	3.90–3.95	4.65–4.70

Iodine and iodine compounds—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	23	Iodine, resublimed	40 cents per pound.
1883	538	Iodine, crude	Free.
1883	108	Iodoform	$2 per pound.
1883	65	Hydriodate, iodide, and iodate of potash	50 cents per pound.
1890	31	Iodine, resublimed	30 cents per pound.
1890	615	Iodine, crude	Free.
1890	32	Iodoform	$1.50 per pound.
1890	71	Hydriodate, iodide, iodate of potash	50 cents per pound.
1894	515	Iodine, crude and resublimed	Free.
1894	22	Iodoform	$1 per pound.
1894	55	Hydriodate, iodide, iodate of potash	25 cents per pound.
1897	27	Iodine, resublimed	20 cents per pound.
1897	581	Iodine, crude	Free.
1897	28	Iodoform	$1 per pound.
1897	64	Hydriodate, iodide, iodate of potash	25 cents per pound.
1909	27	Iodine, resublimed	20 cents per pound.
1909	593	Iodine, crude	Free.
1909	28	Iodoform	75 cents per pound.
1909	62	Hydriodate, iodide, iodate of potash	25 cents per pound.
1913	515	Iodine, crude or resublimed	Free.
1913	38	Iodoform and potassium iodide	15 cents per pound.

COURT AND TREASURY DECISIONS.

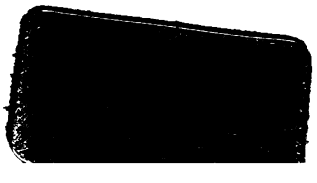
Iodate of potash was mentioned in the same paragraph (62) of the act of 1909 with iodide of potash, but is not more specifically provided for in the act of 1913 than as chemical salts (par. 5).

Hydriodate of potash, which was also mentioned in the act of 1909, is an obsolete name for the iodide and may well be omitted. The iodate is not of sufficient industrial importance to justify specific enumeration. Sodium iodide is, however, an important substitute for potassium iodide, and is classified under paragraph 5 at 15 per cent, which is higher than the rate on potassium iodide.

Potassium iodide is the only potassium compound mentioned by name in schedule A; that is, outside of paragraph 64. It would seem advisable to transfer potassium iodide to paragraph 64.

Aristol, a compound of iodine and thyrmol, claimed by the importer to be in chief value of iodine and used solely as a substitute for iodoform, was held dutiable as a medicinal preparation under paragraph 75 of the act of 1890 and not as iodoform under paragraph 32, by virtue of the similitude clause in section 5 of that act. G. A. 608 (T. D. 11325).

○



UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 39, 40, 41, 42, and 43 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

Paragraph 39:
- Buchu Leaves
- Coca Leaves
- Gentian
- Licorice Root
- Sarsaparilla Root

Paragraph 40:
- Licorice Extract

Paragraph 41:
- Citrate of Lime (See par. 1.)

Paragraph 42:
- Calcined Magnesia
- Magnesium Carbonate
- Magnesium Sulphate or Epsom Salts

Paragraph 43:
- Menthol

REVISED EDITION

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U.S. Tariff Com.
6-4-28

PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this introduction and index the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Dr. Grinnell Jones, E. E. Stanford, and Sidney D. Kirkpatrick, of the chemical division of the commission's staff, and of others.

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BUCHU LEAVES.

SUMMARY.

Description and uses.—Buchu leaves are a crude botanical drug used chiefly in genitourinary diseases, for the most part in proprietary medicines. It is not highly valued by modern therapeutic authorities.

Domestic production.—No effort to grow buchu in this country appears to have been made. Its climatic and soil requirements could probably be met here, should price and demand warrant cultivation. In advance of experiments nothing definite can be said with reference to the probable cost of raising the drug in the United States.

Foreign production.—British South Africa is at present (1919) the only commercial producer of buchu. The plant is a native shrub occurring wild. Owing to extensive collection it is becoming rather rare, and cultural experiments, successful on a small scale, have been reported. In order to conserve the supply, an export duty has been placed on buchu by British South Africa.

Imports.—In amounts and value buchu is one of the more important crude-drug imports. For the years 1911–1917 an average annual amount of 120,603 pounds and an average annual value of $102,808 is reported. America is the largest single consumer of buchu, using under prewar conditions from one-half to four-fifths of the total output. Probably half the imports normally come direct and the remainder chiefly via England.

In December, 1918, buchu was said to be practically out of the American market, owing to shipping difficulties.

For the fiscal years 1914–1917 buchu yielded an average annual revenue of $10,576.

Prices.—During the years 1911–1917 the declared value of buchu imports varied between $0.77 and $1.14 per pound. American wholesale prices from 1912 through 1917 ranged between $0.95 and $1.70 for the preferred grade. By the end of 1918, owing presumably to war scarcity, they had reached $2.75 per pound.

Tariff history.—Buchu was specifically mentioned and made dutiable at 10 cents per pound in the act of July 14, 1862, specifically mentioned on the free list of the act of July 14, 1870, and included without specific mention under the blanket provisions for drugs, crude or advanced, of all succeeding tariffs prior to the act of 1913. Under this act buchu has proved a small but consistent revenue producer at a calculated ad valorem rate ranging from 9.77 to 11.75 (through 1917). Imposition of a duty of 10 cents per pound by the act of 1913 was accompanied by a drop in declared value of 11 cents per pound below the price of the preceding portion of the fiscal year 1914, and the declared value of the commodity declined steadily through 1917.

General Information.

Buchu is a crude botanical drug composed of the dried leaves of *Barosma betulina* (Thunb.) Bart. et Wend., known in commerce as short buchu, or of *Barosma serratifolia* (Curtis) Willdenow, known in commerce as long buchu.

Adulterants and substitutes.—Buchu is the name given by the African natives to a number of shrubs, including those named, several other species of *Barosma*, and some related or other species whose leaves resemble those of the official species. The buchu of commerce has always been an extensively adulterated drug, owing to its high price and the ignorance or dishonesty of the native collectors. A high export duty has recently been placed on this product, which has resulted in enormously stimulating adulteration and substitution. It is apt to be contaminated with twigs, stems, flowers, and fruits far beyond the pharmacopœial allowance of 10 per cent. Among *Barosmas* substituted are *B. crenulata*, so-called oval buchu, formerly official; *B. pulchella*, aniseed buchu; and *B. venusta*. Karoo buchu is the leaves of *Diosma succulenta*. Other spurious buchus are the leaves of *Empleurum ensatum*, *Psoralea obliqua*, *Agathosma villosa*, *A. commutata*, *A. virgata*, and other species whose botanical identity is not known.

Production.—Both official species of buchu are wild shrubs. *B. betulina* is found on mountain slopes at an altitude of 1,000 to 2,000 feet, growing in a red, sandy loam among red sandstone and quartzite. *B. serratifolia* thrives in a moist, but not wet, black, sandy loam containing considerable humus, often in rocky soil or in the shade, at altitudes of 500 to 1,000 feet.

Buchu is usually gathered in a very careless way by Negro laborers, who uproot or otherwise destroy the whole plant at seeding time, when the leaves are said to be most valuable, thus destroying most of the seed. Continual veld fires destroy seedlings and young plants. Thus the native supply of the plants has been largely exhausted. In an effort to remedy the matter the colonial government has put a heavy export duty on the drug and forbidden the free export of plants or seeds.

Some persons in South Africa have experimented in the cultivation of buchu, but it is probable that these experiments, while successful in a small way, have not yet reached the commercial stage.

Buchu may be grown from seed or cuttings; the seedlings are said to be very sensitive and very subject to insect trouble. After transplants become established in well-fertilized soil resembling that of their natural habitat, they grow without much further attention except occasional culture and top dressing. The first picking, of 1 year-old leaves, may be made from the third to fifth year after transplanting, and leaves thereafter may be gathered annually. The leaves should be carefully dried indoors. Much of the commercial product is damaged by improper drying.

Buchus are said to be quite hardy. *B. betulina* and *B. crenulata* were formerly grown in England as ornamentals.

The United States is the largest single consumer of buchu leaves. Apparently about equal quantities arrive via London and direct from South African ports, mainly Cape Town and Port Elizabeth. England and Germany are the other principal consuming nations.

Buchu ranks third in reported American drug leaf imports, being exceeded by senna and coca.

Uses.—Buchu is official in most pharmacopoeias, although they are not agreed as to the species recognized.

Official preparations are fluid extract of buchu, compound fluid extract of buchu, elixir of buchu, compound elixir of buchu, elixir of buchu and potassium acetate.

Buchu is diuretic, tonic, stimulant, carminative, diaphoretic. It is employed as a stimulant in certain conditions of the genitourinary tract, and in chronic catarrh of the bladder and similar affections. Its use by the medical profession has decreased somewhat in recent years.

A volatile oil, said to contain the medicinal principles of buchu, is distilled in Germany.

Buchu in America is used chiefly in proprietary medicine. Both the drug and the oil have been used to a limited extent in the flavoring of gin and other liquors.

Buchu, in common with all drugs whose medicinal principle resides in a volatile oil, deteriorates rapidly in storage, especially after grinding.

Competitive conditions.—The climatic and soil requirements of the buchu plant could doubtless be fulfilled in the United States. Commercial production has apparently not been tried, and there is no way of estimating costs. At present it is very difficult to secure seeds owing to South African export restrictions, but enough for a small plant could doubtless be obtained by sifting the drug. At the experimental farm of Eli Lilly & Co., Indianapolis, 5 per cent of seed thus obtained germinated. Further growth experiments were not reported.

Exports of buchu leaves from South Africa.[1]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1909	260,126	$47,073	1913	163,812	$156,186
1910	273,325	118,964	1914	149,113	134,207
1911	212,082	144,381	1915	151,061	115,745
1912	223,021	186,346	1916	130,794	105,606

[1] Statistics from the South African Journal of Industries, September, 1917, supplied by H. K. Vere-Hodge of the Department of Customs and Excise.

Buchu leaves—Imports for consumption—Revenue.

Fiscal year—	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free		$45,559			
1910	do	130,644	48,652		$0.372	
1911	do	106,345	81,658		.768	
1912	do	181,121	160,608		.887	
1913	do	105,310	114,632		1.090	
1914 [1]	do	18,362	20,860		1.136	
1914 [2]	10 cents per pound.	107,006	109,492	$10,700	1.023	9.77
1915	do	120,704	115,689	12,070	.959	10.43
1916	do	94,520	85,061	9,452	.900	11.11
1917	do	100,809	85,807	10,080	.851	11.75
1918	do	50,685	42,431	5,068	.837	11.95
1919	do	85,303	90,578	5,530	1.061	9.42
1920	do	86,535	138,843	8,654	1.604	6.23

[1] Act of 1909, July 1 to Oct. 3, 1913. [2] Act of 1913, Oct. 4, 1913, to June 30, 1914.

Buchu leaves, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	LONG.	SHORT.
Jan. 1, 1912	$0.55–$0.60	$0.95–$1.00
Apr. 1, 1912	.60– .62	1.15– 1.20
July 1, 1912	.90– 1.00	1.45– 1.50
Sept. 30, 1912	1.20– 1.25	1.60– 1.70
Dec. 30, 1912	1.50– 1.55	1.50– 1.60
Mar. 31, 1913	1.45– 1.50	1.50– 1.60
June 30, 1913	1.40– 1.50	1.45– 1.50
Sept. 29, 1913	1.30– 1.35	1.30– 1.35
Dec. 29, 1913	1.25– 1.30	1.30– 1.35
Mar. 30, 1914	1.25– 1.30	1.35– 1.40
June 30, 1914	1.30– 1.35	1.45– 1.50
Sept. 28, 1914	1.60– 1.80	1.65– 1.70
Dec. 28, 1914	1.30– 1.35	1.45– 1.50
Mar. 29, 1915	1.30– 1.35	1.45– 1.50
June 28, 1915	1.17– 1.19	1.15– 1.20
Sept. 27, 1915	1.00– 1.05	1.05– 1.10
Jan. 3, 1916	1.20– 1.30	1.25– 1.30
Apr. 3, 1916	1.30– 1.35	1.30– 1.35
July 3, 1916	1.30– 1.35	1.18– 1.20
Oct. 2, 1916	1.25	1.20– 1.25
Jan. 1, 1917	1.25	1.18– 1.20
Apr. 2, 1917	1.35	1.30– 1.35
July 2, 1917	1.30	1.28– 1.30
Oct. 1, 1917	1.30	1.25– 1.30
Dec. 31, 1917	1.25– 1.30	1.15– 1.25
Jan. 5, 1918	1.25– 1.30	1.15– 1.25
Apr. 1, 1918	1.40– 1.45	1.33– 1.35
July 1, 1918	1.40– 1.45	1.40– 1.45
Oct. 6, 1918	2.50– 2.55	2.50– 2.55
Jan. 6, 1919	2.60– 2.75	2.60– 2.75
Apr. 7, 1919	1.50– 1.75	1.50– 1.75
July 7, 1919	(1)	2.15– 2.25
Oct. 6, 1919	(1)	2.25– 2.35
January, 1920	2.35– 2.50	2.35– 2.50
Apr. 5, 1920	(1)	3.75– 4.00
July 5, 1920	3.25– 3.35	4.00
Oct. 4, 1920	3.30– 3.35	3.40– 3.50

Buchu leaves—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883....	636	Drugs * * * leaves * * * not edible * * * in a crude state * * * not advanced * * * and not specially enumerated or provided for * * *.	Free.
1883....	94	All * * * leaves * * * not edible but which have been advanced in value or condition by refining or grinding, or by other processes of manufacture, and not specially enumerated or provided for * * *.	10 per cent ad valorem.
1890....	560	Drugs, such as * * * leaves * * * not edible * * * in a crude state, * * * not advanced * * * not specially provided for * * *.	Free.
1890....	24	Drugs, such as * * * leaves, * * * not edible * * * advanced in value or condition by refining or grinding or by other process of manufacture, and not specially enumerated or provided for * * *.	10 per cent ad valorem.
1894....	470	Drugs, such as * * * leaves * * * drugs which are not edible * * * not * * * advanced * * * not specially provided for * * *.	Free.
1894....	16½	Drugs, such as * * * leaves * * * not edible * * * advanced in value or condition by refining or grinding or by other process of manufacture, and not specially provided for * * *.	10 per cent ad valorem.
1897....	548	Drugs, such as * * * leaves * * * which are drugs not and edible * * * in a crude state * * * not advanced * * * not specially provided for * * *.	Free.
1897....	20	Drugs, such as * * * leaves * * * which are drugs and not edible, but which are advanced in value or condition by refining, grinding or other process, and not specially provided for * * *.	One-fourth of 1 cent per pound, plus 10 per cent ad valorem.
1909....	559	Drugs, such as * * * leaves * * * which are natural and uncompounded drugs and not edible and not specially provided for * * * in a crude state, not advanced * * * *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be admitted free of duty under this paragraph.	Free.
1909....	20	Drugs, such as * * * leaves * * * which are natural and uncompounded drugs and not edible, and not specially provided for * * * but which are advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the drugs, and the prevention of decay or deterioration pending manufacture * * * *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be classified for duty under this paragraph.	One-fourth of 1 cent per pound plus 10 per cent ad valorem.
1913....	39	* * * Buchu leaves * * *.....	10 cents per pound.

[1] Nominal.

COCA LEAVES.

SUMMARY.

Description.—Coca leaves are a crude drug used chiefly in the manufacture of cocaine. After the removal of the cocaine, the residue of the leaves has a considerable use in the compounding of soft drinks. They are in no way connected with the product cocoa, which is derived from an entirely different plant.

Domestic production.—Coca leaves are not commercially produced within the territorial limits of the United States. The plant could be grown in our tropical possessions, in some of which it has been experimentally tested, but on account of the moral dangers involved its production has not been undertaken and should not be encouraged.

Foreign production.—Coca leaves are commercially produced in South America, India, and the Dutch East Indies. The plant is native to Peru, Bolivia, and Ecuador, where it has been cultivated by the natives for centuries, little or none of the leaves of commerce being collected from wild plants. Large amounts are consumed locally, as well as for the manufacture of crude cocaine, which is shipped to Europe and America for further purification. Development of cultivation in the East Indies is rather recent.

Imports.—American imports of coca leaves are chiefly of Peruvian origin, small amounts being contributed by other South American countries. In recent years occasional importations have come from Java, and it is probable that this source is destined to increase in importance. Commerce with producing countries is chiefly direct, though some coca leaves are imported through England, Germany, and Holland.

In amount of imports coca ranks second to senna. For the years 1909–1918 an average annual amount of 979,312 pounds and an average annual value of $136,680 is reported. Yearly totals show less variation than most drug products.

Revenue practically doubled with the raise of duty from 5 cents to 10 cents per pound imposed by the act of 1913.

Prices.—Declared import value per pound has ranged from 9 cents in 1915 to 19.1 cents in 1911.

Truxillo coca, the chief variety, was very steady at 35 and 40 cents per pound in the American wholesale market from 1914 through 1917. In 1918 (December) it rose to 55 and 56 cents.

Tariff history.—Coca leaves, prior to the act of 1909, were included without specific mention in the general paragraphs covering crude and advanced drugs. Their specific mention, and the rates of duty adopted (5 cents and 10 cents per pound) in the acts of 1909 and 1913 are presumably due to a desire to keep coca leaves out of the hands of irresponsible persons.

General Information.

Coca leaves are the dried leaves of *Erythroxylon coca* Lam. (family Erythroxylaceae), known commercially as Huanuco coca, or of *E. truxillense* Rusby, known commercially as Truxillo coca.

Synonyms.—Erythroxylon U. S. P. 1880, Cocae Folia Br. Coca-blatter Ger. Feuilles de coca Fr. Ipadu sp.

Sources.—The coca plants are shrubs of the eastern Andes, now introduced to some extent into other parts of tropical South America, Central America, and the West and East Indies, though relatively little of the commercial product originates outside of Peru, Bolivia, and Ecuador.

Adulterants and substitutes.—The leaves of coca are very characteristic and easily identified; practically no substitution of other species in the whole product has been reported. The plant cultivated as coca outside South America is considered botanically different from the species above named, and may therefore be considered as a substitute. The leaves contain cocaine, in part, in a combined form, but are a valuable source of the alkaloid. Other South American *Erythroxylons* contain cocaine but appear not to occur in commerce. Cocaine is extracted from some of these in South America.

History.—Coca leaves have been used by the Indians of Peru and some neighboring portions of South America since prehistoric time. There the leaves mixed with ashes or lime are chewed for the purpose of allaying hunger, appeasing thirst, preventing fatigue, and overcoming mental depression. Coca is especially used by the natives to increase their endurance for exhausting labor under untoward conditions in the mines or by the "runners" of the Andes, who carry heavy loads through the extremely rarified air of great heights for days with no sustenance save the chewing of coca leaves and an occasional scanty handful of maize or quinoa. European observers testify to the action of coca in preventing hunger, thirst, and fatigue, and its effect in assisting respiration at great heights, basing their verdict both on observation and personal experience.

The use of coca leaves is said rarely to become excessive or to produce injurious effects in the natives, but sometimes to produce mental degeneration and hallucinations in foreigners.

Coca leaves were first exported to England in quantity about 1870. There the drug rapidly came into prominence because of its reported virtues. Extensive chemical and pharmacological investigations demonstrated to the satisfaction of the scientific and professional world that the drug was practically inert, being at best something like a weak caffeine-bearing stimulant, and its use accordingly fell into disrepute until Koller, in 1884, demonstrated the local anesthetic power of cocaine previously discovered in coca leaves in 1855. This discovery immediately stimulated renewed investigation of coca leaves. No definitely satisfactory explanation of the reputed properties of the leaves in South America has yet been formulated. Other alkaloids have been isolated, but their properties, so far as examined, do not explain the matter. Rusby, who has investigated the fresh drug in South America, has stated in his original publication (see bibliography) his belief that the effect is due to a rapidly volatile or unstable principle present in the green or freshly dried leaves, but which quickly disappears during storage and therefore is not present

in the commercial material which reaches the United States and other importing countries. In a later statement (U. S. D. A. Notice of Judgment 1455, p. 18) this authority states that "it is to get the effect of the cocaine that the natives of the countries in which it is grown chew it" (the leaf). The extensive use of coca leaves in American "soft drinks" is doubtless due to the reputation of the drug as a stimulant.

Coca leaves are first specifically mentioned in the tariff of 1909, having previously been included in the provisions for "drugs, such as * * * leaves * * *," etc. The assessment of a duty of 5 cents per pound in this tariff and of 10 cents per pound in the present law may be traced to the recent abuse of cocaine. If the cocaine content of the leaves be taken as 0.5 per cent, the present duty is equivalent to a duty of $1.25 per ounce on the contained cocaine.

Coca leaves are included in the provisions of the Harrison narcotic law; decocainized leaves or their extract are not.

Production.—Coca leaves are almost entirely a cultivated product; the cultivated species are known wild only as recent escapes, and probably have become considerably modified owing to long cultivation. The coca shrub is cultivated in the Andes on terraced plantations, or cocales, cleared from the forests on warm declivities. It thrives best in a moist atmosphere under scattered trees, but not deep shade, which, as well as low elevation, develops bitterness. Any variation in this or in the prescribed soil, exposure, or curing may affect quality.

Propagation is by seedling or sometimes by cuttings. Culture is similar to that of the peach in the United States. The first harvest is made from 18 to 30 months from planting. Two, three, and even four crops may be obtained in a year from plants growing on a rich soil, and the shrubs will yield crops from 40 to 50 years. The leaves are picked carefully by hand, dried in the sun, and packed much like tea leaves, and used or exported as soon as possible, as their cocaine content diminishes rapidly on keeping, especially in a moist, hot climate.

Peruvian ports are the principal ports of export. Coca is cultivated also in the other parts of South America, the West and East Indies, especially India, Ceylon, and Java. The products of the East Indies are considered inferior to the South American coca, and have been little known in American trade. In the last few years, however, several shipments of Java coca leaves have been received direct, and it is not improbable that some shipments arriving from England and Germany have originated in the East Indies.

Ceylonese exports in 1911 were 1,432 pounds and in 1912 1,186 pounds, valued at £4,654 and £3,838, respectively. The normal price in Colombo was said to be 4 to 7 d. per pound, and in London 6 to 10 d. per pound. (MacMillan, 1913.)

Competitive conditions.—The slightest frost is said to be fatal to the coca shrub; this tenderness precludes its growth in the major portion of the United States. It is said to grow vigorously in Hawaii and the Philippines, but no effort has been made to develop the industry there, largely for the reason that it has been felt unwise to expose the laborers to the cocaine habit.

Uses.—Coca leaves were formerly official (U. S. P. VIII), but are not included in the present pharmacopœia or in the National Formulary. The drug finds limited use in fluid extract, tincture, or elixir, but its main use is in the preparation of cocaine, which, as a definite chemical compound, is generally to be preferred to the crude drug. The medicinal preparations of the crude leaf are becoming more and more obsolete.

Decocainized coca leaves have been extensively used in the preparation of "soft drinks." Some of these products have been found to contain small quantities of cocaine, but in the main caffeine is the active ingredient.

Coca leaves—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1909	Free	1,100,649	$126,881		$0.115	
1910 [1]	do	117,134	16,947		.145	
1910 [2]	5 cents per pound.	591,412	81,507	$29,570	.138	36.28
1911	do	1,226,771	234,162	61,338	.191	26.19
1912	do	1,179,540	201,950	58,977	.171	29.20
1913	do	1,175,780	139,035	58,789	.118	42.28
1914 [4]	do	202,062	30,204	10,103	.150	33.45
1914 [3]	10 cents per pound.	509,502	61,180	50,950	.120	83.28
1915	do	1,048,312	98,870	104,831	.090	106.03
1916	do	947,537	106,627	94,753	.113	88.86
1917	do	634,932	90,131	63,493	.142	70.45
1918	do	1,059,484	179,312	105,948	.169	59.09
1919	do	1,023,321	186,477	102,332	.182	54.88
Calendar years:						
1918	do	1,346,013	219,153	134,601	.162	61.42
1919 [5]	do	795,074	167,957	79,507	.211	47.34
1920	do	432,177	113,196	43,217	.261	38.18

[1] Act of 1897, July 1 to Aug. 5, 1909.
[2] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909, July 1 to Oct. 3, 1913.
[4] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[5] 6 months.

Coca leaves, prices per pound, wholesale, New York, spot.

[From Oil Paint and Drug Reporter.]

TRUXILLO.	
Jan. 1, 1912	$0.30–$0.35
Apr. 1, 1912	.28–.35
July 1, 1912	.28–.33
Sept. 30, 1912	.28–.33
Dec. 30, 1912	.25–.28
Mar. 31, 1913	.25–.28
June 30, 1913	.21–.22
Sept. 29, 1913	.21–.22
Dec. 29, 1913	.25
Mar. 31, 1914	.25
June 30, 1914	.25
Sept. 28, 1914	.45–.50
Dec. 28, 1914	.35–.40
Mar. 29, 1915	.35–.40
June 28, 1915	.35–.40
Sept. 27, 1915	.35–.40
Jan. 3, 1916	.35–.40
Apr. 3, 1916	.35–.40
July 3, 1916	.35–.40
Oct. 2, 1916	.35–.40
Jan. 1, 1917	.35–.40
Apr. 2, 1917	.35–.40
Apr. 1, 1918	(1)
July 1, 1918	(1)

TRUXILLO—continued.	
Oct. 7, 1918	$0.55–$0.56
Jan. 6, 1919	.55–.56
Apr. 7, 1919	.65–.70
July 7, 1919	.65–.70
Oct. 6, 1919	.65–.70
HUANUCO.	
Sept. 30, 1912	.30
Dec. 30, 1912	.30
Mar. 31, 1913	.30
June 30, 1913	.30
Sept. 29, 1913	.30
Dec. 29, 1913	.30
Mar. 30, 1914	.30
June 30, 1914	.30
Apr. 1, 1918	(1)
July 1, 1918	(1)
Oct. 7, 1918	(1)
Jan. 6, 1919	(1)
Apr. 7, 1919	(1)
July 7, 1919	(1)
Oct. 6, 1919	(1)

[1] Nominal.

Coca leaves—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	94	All * * * leaves, * * * not edible, but which have been advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially enumerated or provided for.	10 per cent ad valorem.
1883	636	Drugs, * * * leaves, * * * not edible, * * * in a crude state, and not advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially enumerated or provided for.	Free.
1890	24	Drugs, such as * * * leaves, * * * not edible, but which have been advanced in value or condition by refining or grinding, or by other process of manufacture, not specially provided for.	10 per cent ad valorem.
1890	560	Drugs such as * * * leaves, * * * not edible, and are in a state, and not advanced in value or condition by refining or grinding, or by other process of manufacture, not specially provided for.	Free.
1894	16½	Drugs, such as * * * leaves, * * * not edible, but which are advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially provided for.	10 per cent ad valorem.
1894	470	Drugs, such as * * * leaves, * * * not edible, and which have not been advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially provided for.	Free.
1897	20	Drugs, such as * * * leaves, * * * which are drugs and not edible, but which are advanced in value or condition by refining, grinding, or other process, and not specially provided for.	One-fourth of 1 cent per pound, plus 10 per cent ad valorem.
1897	548	Drugs, such as * * * leaves, * * * which are drugs and not edible, and are in a crude state, and not advanced in value or condition by refining or grinding, or by other process, and not specially provided for.	Free.
1909	41	Coca leaves	5 cents per pound.
1913	39	.....do	10 cents per pound.

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Gentian has no important competitor among American drugs, although a considerable number of domestic articles find limited use as bitters. Of the other numerous imported simple bitters, quassia is of chief importance. Nux vomica and cinchona are also important as bitters, although their action is not strictly analogous to that of gentian, being due chiefly to their contained alkaloids.

From October, 1913, through the fiscal year 1918, gentian, dutiable at one-fourth cent per pound, produced an average annual revenue of $1,338.

PRICES.

Gentian is one of the cheaper products of its class. Declared value of imports for the years 1909–1916 ranged from 3.6 cents to 8 cents per pound, and in 1917 (owing probably to war and transport conditions) reached 12.2 cents.

American wholesale prices from 1912 through 1915 showed little variation, the maximum being 8¾–9½ cents per pound in 1915. During 1916 the drug rose to 28–29 cents, due to heavy decrease in imports, but soon declined to 18 and 20 cents. In 1917 a very considerable increase in imports caused the price to be very much lower, down to 13 cents per pound. During 1917 and 1918 the price climbed gr dually to 18 cents until January, 1919, caused by exceedingly low import figure. Since the war the price has dropped as low as 12½ cents.

TARIFF HISTORY.

The act of 1913 carries the following provision: "Leaves and roots: * * *; *gentian, one-fourth cent per pound;* * * *.

In previous acts gentian was governed without specific mention under general provisions for drug roots similar in purport to the present paragraphs 27 and 477.

Gentian—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1909	Free	1,485,389	$62,445		$0.042	
1910	do	1,177,433	42,356		.036	
1911	do	1,537,919	56,902		.037	
1912	do	1,585,612	67,837		.043	
1913	do	1,796,928	88,281		.049	
1914 [1]	do	831,493	40,164		.048	
1914 [2]	¼ cent per pound	1,350,442	68,955	$3,376	.051	4.90
1915	do	1,022,252	55,553	2,555	.054	4.60
1916	do	788,307	63,240	1,970	.080	3.12
1917	do	1,780,044	218,377	4,450	.122	2.04
1918	do	412,590	46,516	1,031	.112	2.22
1919	do	188,402	26,653	471	.141	1.77
Calendar year:						
1918	do	275,747	35,913	689	.132	1.92
1919	do	603,594	66,238	1,509	.109	2.28
1920 [3]	do	414,394	39,479	1,036	.095	2.62

[1] Act of 1909—July 1 to Oct. 3, 1913.
[2] Act of 1913—Oct. 4, 1913, to June 30, 1914.
[3] 6 months ending June 30, 1920.

Gentian, prices, cents per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	6 - 6½	July, 1915	8½- 9½
Apr. 1, 1912	6 - 6½	October, 1915	8½- 9
July 1, 1912	7 - 8	January, 1916	18
Sept. 30, 1912	7 - 8	April, 1916	28 -29
Dec. 30, 1912	6½- 7	July, 1916	25 -26
Mar. 31, 1913	6½- 7	October, 1916	18 -20
June 30, 1913	6½- 7	Jan. 1, 1917	13 -14
Sept. 29, 1913	6½- 6¾	Apr. 2, 1917	16 -17
Dec. 29, 1913	6½- 6¾	July 2, 1917	15 -15½
Mar. 30, 1914	6½- 6¾	Oct. 1, 1917	15 -16
June 29, 1914	6½- 6¾	Dec. 31, 1917	14 -17½
August, 1914	6½- 6¾	Jan. 5, 1918	14 -17½
January, 1915	7½- 8½	Apr. 1, 1918	15 -16
April, 1915	8¾- 9		

Date.	Whole.	Ground.	Powdered.
July 1, 1918	16½-17	18½-19	19½-20
Oct. 7, 1918	16½-17	18½-19	19½-20
Jan. 6, 1919	18 -19	20 -21	21 -22
Apr. 7, 1919	14 -15	17 -18	18 -19
July 7, 1919	14 -15	16 -17	17 -18
Oct. 6, 1919	13½-14	16½-17	17½-18
Jan. 5, 1920	13½-14	16½-17	17½-18
Apr. 5, 1920	12 -13½	15 -15½	16 -16½
July 5, 1920	12½-13	13½-15	14½-16
Oct. 4, 1920	12½-13	13½-15	16 -17

Gentian—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	636	Drugs * * * roots * * * not edible * * * in a crude state * * * not advanced * * * and not specially enumerated or provided for * * *.	Free.
1883	94	All * * * roots * * * not edible but which have been advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially enumerated or provided for * * *.	10 per cent ad valorem.
1890	560	Drugs, such as * * * roots * * * not edible * * * in a crude state, * * * not advanced * * * not specially provided for.	Free.
1890	24	Drugs, such as * * * roots, * * * not edible * * * advanced in value or condition by refining or grinding or by other process of manufacture, and not specially enumerated or provided for * * *.	10 per cent ad valorem.
1894	470	Drugs, such as * * * roots * * * drugs which are not edible * * * not * * * advanced * * * not specially provided for * * *.	Free.
1894	16½	Drugs, such as * * * roots * * * not edible * * * advanced in value or condition by refining or grinding or by other process of manufacture, and not specially provided for * * *	10 per cent ad valorem.
1897	548	Drugs, such as * * * roots * * * which are drugs and not edible * * * in a crude state * * * not advanced * * * not specially provided for * * *.	Free.
1897	20	Drugs, such as * * * roots * * * which are drugs and not edible, but which are advanced in value or condition by refining, grinding, or other process, and not specially provided for * * *.	½ of 1 cent per pound, plus 10 per cent ad valorem.
1909	559	Drugs, such as * * * roots * * * which are natural and uncompounded drugs and not edible and not specially provided for * * * in a crude state, not advanced * * *: *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be admitted free of duty under this paragraph.	Free.
1909	20	Drugs, such as * * * roots * * * which are natural and uncompounded drugs and not edible, and not specially provided for * * * but which are advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the drugs, and the prevention of decay or deterioration pending manufacture * * *: *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be classified for duty under this paragraph.	½ of 1 cent per pound, plus 10 per cent ad valorem.
1913	39	* * * Gentian * * *.....	½ of 1 cent per pound.

COURT AND TREASURY DECISIONS.

The provision for gentian covers both leaves and roots. Abstract 39291, of 1916.

LICORICE ROOT.

SUMMARY.

DESCRIPTION.

Licorice root is a plant product used as a drug, in tobacco manufacture, and in the preparation of licorice paste. It should yield about 20 per cent of its weight in paste.

DOMESTIC PRODUCTION.

The licorice plant is not native to America, but has been introduced in various localities and grows readily in States where severe frosts do not occur. Occasional attempts at commercial production have been noted, but costs of raising and curing the product have usually been too high to enable it to compete with imports.

FOREIGN PRODUCTION.

The licorice plant is grown extensively in southern Europe and Asia Minor, where it also occurs wild. Spain and Italy are the chief centers of cultivation, and Russia and Asia Minor furnish large quantities of wild licorice. Spanish licorice is chiefly exported into Europe, while the Italian is manufactured into paste in Italy. Cultivation on a lesser scale is carried on in England, France, Germany, Austria, and other European countries. Under war conditions imports from China have been noted. Chinese licorice is derived from a species of plant differing from those which furnish the European and Turkish product.

IMPORTS.

American imports of licorice have in normal times come chiefly from Turkey in Asia and Asiatic and European Russia. Imports from Spain, Italy, and other European countries have been comparatively insignificant. Under war conditions licorice imports have been severely cut. For the year 1918 an amount of 27,051,021 pounds, valued at $1,863,886, is reported, whereas for the years 1909–1917 the average annual amount is 85,225,819 pounds and the value $1,693,014.

Licorice imports of the United States have chiefly been used by tobacco manufacturers, who prepare from the root the paste used for flavoring chewing tobacco. Under war conditions substitutes for licorice paste containing comparatively small amounts of licorice have been developed.

REVENUE.

Since the imposition of duty in 1914 licorice root has yielded an average annual revenue of $137,950. The rate of one-fourth cent per pound, equivalent to an ad valorem of 14.87 per cent in 1914, was equivalent to 3.63 in 1918.

PRICES.

Licorice root is a very cheap commodity. For the years 1909–1915 import declared values range from 1.6 cents to 1.9 cents per pound. For the years 1916–1918 the value rose to 3.4 cents, 3.7 cents, and 6.9 cents, respectively. Several grades of licorice are quoted on the New York drug market. Selected licorice quoted at 7½ to 9 cents per pound in 1912 had risen to 31 and 32 cents per pound at the end of 1918.

TARIFF HISTORY.

The act of 1913 contains the following provision:

39. "Leaves and roots: * * *; licorice root, one-fourth cent per pound; * * *."

Previous tariffs (from 1883–1909) included licorice, unground, on the free list. In these tariffs ground or advanced licorice root was dutiable as an advanced drug at 10 per cent ad valorem under the acts of 1883 and 1890, and at one-fourth cent per pound plus 10 per cent ad valorem in 1897 and 1909.

General Information.

DESCRIPTION.

Licorice root is the dried rhizome and roots of *Glycyrrhiza glabra typica* Regel et Harder, known in commerce as Spanish licorice, or of *Glychrrhiza glabra glandulifera* Regel et Harder, known in commerce as Russian licorice (Fam. Leguminosae). The licorice plant is a native of southeastern Europe and southwestern Asia as far as Persia, the variety *typica* ranging westward and the variety *Glandulifera* to the eastward.

Numerous commercial varieties, depending on different producing sections, are recognized by the trade. Spanish licorice, as here recognized, may include Italian, Sicilian, Turkish, Alicante, Tortosa, etc.

ADULTERANTS AND SUBSTITUTES.

Licorice root is frequently adulterated with the underground stem, worm-eaten and fibrous roots with little sweetness, and the roots of unofficial species, especially *G. echinata* L. *G. uralensis* Fish, Chinese or Asiatic licorice, is said to compare favorably with the official species and is occasionally imported, especially under war conditions. It is not apparently regarded by the trade as equal in value to the official species.

G. lepidota Pursh, the American wild licorice of the United States, is somewhat used locally.

Indian licorice, so-called, the root of *Abrus precatorius* L. (Jequirity) was recognized in the Indian Pharmacopoeia under the mistaken belief that it could be used as a substitute for licorice. It contains a small amount of glycyrrhizin (the sweet principle of licorice) but poisonous substances also.

PRODUCTION IN GENERAL.

The licorice plant is a perennial, running shrub. Russian licorice has been comparatively little cultivated, owing to the extensive areas of wild land which it occupies. Up to 1890 the cultivation of Spanish licorice was small or moderate in comparison with the wild collection. Owing to the depletion of natural supplies of root of good quality this cultivation has increased rapidly in southern and south-central Europe.

Propagation is by cuttings. Growth for the first two years is slight, and intervening spaces are used for the production of other crops. After the second year the licorice covers the ground and excludes other growth. The roots are harvested and dried the third or fourth year; 5,000 pounds per acre is a good yield.

The licorice plant can not endure severe freezing. It has been found that a climate particularly favorable to the orange is also favorable to licorice; while it can grow in a much colder climate, its root is said to be deficient in the sweet substances which give it value. It thrives in deep, moist, sandy, or loamy soil; the root penetrates deeply, and the plant readily propagates from detached pieces, rendering it a persistent and almost ineradicable weed in cultivated grounds. The plant is little subject to disease.

Production of "Spanish licorice."—Spain and Italy are the chief countries cultivating licorice. The Spanish root is chiefly exported; the Italian is manufactured into paste almost wholly in Italy. The chief districts of cultivation in Spain are the valleys of the Ebro and Guadalquivir, in the neighborhoods of Alicante, Tortosa, Barcelona, Cordoba, and Elche. Wild licorice is also common in Spain. Italian cultivation centers in Calabria, Teramo, lower Abruzzo, and in Sicily. In the latter Caltinisetta is the center of cutlivation; much wild licorice is collected in Catania. Export centers are Seville, Alicante, Barcelona, Bilbao, and Malaga.

Licorice is also cultivated in southern France.

Cultivation on a small scale has existed in England for a long time; the roots here are utilized for domestic consumption without drying. Surrey, Yorkshire, Kew, and Islesworth are the chief centers.

In Austria licorice is cultivated at Auspitz in Moravia and in Sassin and some other Hungarian districts.

Bamberg is the chief center of German cultivation; licorice growing here was formerly an important industry, but the amount produced has been of recent years (1910) unimportant as compared with imports.

Licorice of the Spanish type is cultivated to a small extent in Asia Minor near Smyrna and in Syria in the neighborhood of Antioch. East of Smyrna and in the interior of Asia Minor vast areas are covered with wild licorice. Licorice from Asia Minor and Anatolia is chiefly shipped through Smyrna to America. In respect to sweetness this product is said to stand midway between that from Spain and Russia.

Production of Russian licorice.—Russian licorice has been known to the trade since the beginning of the nineteenth century, but has been important in commerce only since 1870. The first supplies came from south Russia in the districts of northern Caucasus, but in recent years that from the Ural region has predominated. This is

apparently due to the superiority of the latter, as wild licorice is still widespread in northern Caucasia, covering immense areas with an almost impenetrable jungle like growth; the gathered product, when trade conditions are unfavorable, is used for fuel by the peasants.

Ural licorice is chiefly carried to Nijni Novgorod and thence to Moscow, Petrograd, and Hamburg. Licorice is also an important product of Trans-Caucasia.

As previously stated, Russian licorice is chiefly a wild product. It is cultivated, however, in the district of Astrakhan, especially on the islands of the Volga delta and in Trans-Caucasia near Batum and Elizabethpol.

Russian licorice has formerly been exported in the root, which is usually peeled, while the Spanish product is not. This constitutes one of the reasons for the trade preference of the Russian variety. Recently extraction plants have been set up at Elizabethpol and other points.

The wild product of Trans-Caucasia is collected by nomadic Tartar tribes, and the traffic is monopolized by the English through contract with the native chiefs.

In Russian Turkestan licorice grows wild in great quantities on both sides of the Amu-Daria. The province of Tchardjoui is the center of collection. The root moves for the most part through Krasnovodsk and Batum to England and America. Exports from Russian Turkestan in 1909 were about 21,600,000 pounds.

Production in other countries.—Persia affords licorice of a type differing somewhat from those named above. Exports go chiefly to India and Turkey and to some extent to Europe.

Licorice culture and manufacture was introduced into Australia and New Zealand about 1880. The plant thrives well, especially in New South Wales, and yields a good product; this is locally consumed.

Numerous attempts have been made to cultivate licorice in the United States, but in general it has not paid. Small amounts of California licorice appeared in American trade in 1896, but at present it is not commercially known.

Chinese licorice, mentioned under substitutes, appears to be produced not only in China proper, but throughout southern Siberia, Mongolia, and Tibet. It is chiefly consumed in China.

USES.

By far the largest proportion of licorice imported into the United States is manufactured into paste (see par. 40), which is used in flavoring chewing tobacco and to a lesser extent in smoking tobacco. The ground root is also used in this connection. Probably 90 per cent of imported licorice is used in tobacco manufacture. Licorice is used to a minor extent in confectionery, chiefly in lollypops and other children's specialties. In Great Britain it is used in the brewing industry, but is not important in this connection in America.

Licorice (glycyrrhiza) as a drug is official in all pharmacopœias but is therapeutically unimportant. It is an excellent demulcent and slightly laxative, and is principally used to mask the taste of bitter or nauseous medicines and mechanically as an excipient and dryer in pills, troches, etc. Its official preparations include the elixir,

extract, pure extract, fluid extract, compound mixture, compound powder, aqueous elixir, aromatic elixir, and fluid gylcerate of glycyrrhiza.

Exports of licorice root from Italy—Production in principal foreign countries.

Country.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
France	76,720	$4,030	53,131	$2,791	49,604	$2,823
United Kingdom	15,212	799	9,480	498	24,250	1,379
Belgium	63,272	3,323	110,230	5,790	63,713	3,626
United States	1,102	58	54,013	2,837	11,905	677
Austria-Hungary	34,392	1,806	23,809	1,251	48,281	2,747
All other	43,210	2,270	11,023	579	97,002	5,527
Total	233,908	12,286	261,686	13,746	294,755	16,779

Country.	1912		1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
France	61,508	$3,500	46,076	$2,622	35,494	$2,020	145,283	$10,209
United Kingdom	6,614	376	11,464	652	13,228	753	86,861	6,083
Belgium	6,614	376	9,259	527	5,511	313		
United States	323,415	18,404	978,622	55,687	2,628,765	149,587	3,769,205	263,978
Austria-Hungary	13,889	790	31,746	1,987	1,323	75	1,323	93
All other	42,989	2,642	13,889	624	59,304	3,408	29,982	2,228
Total	455,029	26,088	1,091,056	62,099	2,743,625	156,156	4,032,654	282,591

Exports of licorice root from France—Production in principal foreign countries.

Country.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	307,542	$10,769	431,220	$15,100	261,686	$9,164
Belgium	239,419	8,384	245,592	8,600	67,240	2,355
United States	108,907	3,814	200,125	10,160	531,088	18,597
Italy	97,223	3,405	123,017	4,308	77,822	2,725
Netherlands	79,807	2,795	84,436	2,957	67,240	2,355
Germany	54,454	1,907	167,109	5,852	170,636	5,975
All other	134,260	4,701	176,588	6,183	361,335	12,653
Total	1,021,612	35,775	1,518,087	53,160	1,537,047	53,824

Country.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	218,255	$11,464	486,114	$25,534	535,718	$28,139
Belgium	124,339	6,531	222,003	11,661	114,198	5,998
United States	83,995	4,412				
Italy	158,952	8,349	215,169	11,302	219,799	11,545
Netherlands	55,556	2,918	104,719	5,501	48,060	2,524
Germany	31,746	1,668	61,729	3,242	66,138	3,474
All other	180,998	9,507	264,552	13,896	187,611	9,856
Total	853,841	44,849	1,354,286	71,136	1,171,524	61,536

Exports of licorice root from Spain—Production in principal foreign countries.

Country.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United States	2,571,379	$78,788	1,885,169	$57,762	2,910,978	$89,194
France	1,331,488	42,330	2,020,809	61,919	1,752,289	53,691
All other	627,264	19,220	136,453	4,181	300,074	9,195
Total	4,580,131	140,338	4,042,431	123,862	4,963,341	152,080

Country.	1912		1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
United States	1,853,030	$56,778	1,565,502	$42,178	2,741,027	$83,986	2,969,613	$90,990
France	1,678,435	51,428	1,848,233	56,631	1,274,065	39,038	2,261,684	69,299
All other	370,099	11,340	1,156,447	43,154	642,374	19,683	429,011	13,145
Total	3,901,564	119,546	4,570,182	141,963	4,657,466	142,707	5,660,308	173,434

Licorice root—Imports by countries (fiscal years).

[General imports.]

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Turkey in Asia	53,472,835	$850,795	42,294,803	$628,120	76,579,221	$1,200,813
Russia, Asiatic	16,458,609	268,970	9,187,780	149,706	20,248,631	330,042
Russia in Europe	24,672,459	402,019	27,080,595	441,640	24,909,579	408,096
Spain	2,290,303	90,069	3,263,161	134,372	2,737,943	101,641
Italy	1,124	19	61,302	1,059	.....	.....
China	.....	.....	.....	.....	500	10
England	427,180	4,652	.....	.....	20,431	490
France	380,323	9,389	272,350	7,782	599,503	16,428
Germany	39,943	2,981	27,531	1,754	39,078	2,621
Austria-Hungary	.....	.....	14,835	392	.....	.....
All other	.....	.....	5,130	252	604	94
Total	97,742,776	1,628,894	82,207,496	1,365,077	125,135,490	2,060,235

Imported from—	1912		1913		1914 [1]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Turkey in Asia	39,812,334	$630,562	63,882,480	$1,042,093	56,355,101	$921,520
Russia in Asia	9,856,000	165,985	17,007,861	286,365	23,513,529	396,843
Russia in Europe	29,710,855	345,624	21,550,091	368,161	30,907,986	513,360
Spain	3,023,079	140,954	2,025,252	82,429	3,536,360	157,875
Italy	10,379	452	258,314	10,761	976,304	41,266
China	800	144	.....	.....	.....	.....
England	16,465	618	.....	.....	28,162	1,078
France	1,101,912	22,451	270,607	11,468	233,765	10,140
Germany	38,957	2,572	64,722	3,784	80,300	4,117
Austria-Hungary	11,200	392	56,082	942	2,200	125
All other	1,044	179	818	63	25,424	868
Total	74,582,225	1,309,789	105,116,227	1,806,066	115,636,131	2,047,192

[1] Includes both free and dutiable.

Licorice root—Imports by countries (fiscal years)—Continued.

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Turkey in Asia	47,076,323	$793,594	11,722,978	$260,842	.....	.....
Russia in Asia	6,089,160	103,072	9,352,000	557,096	41,470,742	$1,102,947
Russia in Europe	.....	.....	8,970,552	292,325	1,482,880	59,580
Spain	2,448,221	121,872	3,864,258	193,385	4,755,556	427,318
Italy	2,613,775	110,546	3,768,864	156,281	1,753,521	33,591
Greece	.....	.....	1,555,172	50,314	4,843,338	204,588
China	.....	.....	1,085,073	42,663	3,644,203	191,590
England	69,289	3,518	483,823	41,848	1,023,731	120,548
France	104,918	3,857	197,487	14,268	415,542	49,872
Germany	12,378	262	1,138	161	.....	.....
All other	7,544,437	116,268	1,950	388	10,711	788
Total	65,958,501	1,252,989	41,003,295	1,609,571	59,400,224	2,190,822

Licorice root (dutiable)—Imports by countries (fiscal years).

Imported from—	1918		1918[1]		1919[1]		1920[2]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Turkey (Asia)	.....	.....	.....	.....	18,351,046	$1,237,632	.....	.....
Russia (Asia)	6,057,800	$174,659	6,056,200	$174,632	3,119,368	146,206	.....	.....
Russia (Europe)	8,188,439	639,900	2,426,977	204,300	.....	.....	.....	.....
Spain	5,270,318	541,901	7,308,178	940,377	6,181,966	770,781	.....	.....
Italy	1,916,149	115,982	85,920	11,458	4,946,107	464,679	.....	.....
Greece	.....	.....	2,782,294	160,617	1,812,247	175,621	.....	.....
China	4,300,302	278,174	5,310,458	353,754	12,081,886	783,045	.....	.....
England	92,428	13,649	268,888	61,310	754,904	102,744	.....	.....
France	340,051	24,437	16,160	3,381	.....	.....	.....	.....
Japan	742,533	58,353	2,839,024	186,796	78,041	9,651	.....	.....
All other	74,912	6,872	6,210	1,664	2,636,108	224,260	.....	.....
Total	26,982,932	1,853,927	27,100,309	1,997,269	49,891,673	3,864,619	.....	.....
Total not stated by countries	.....	.....	.....	.....	.....	.....	44,216,908	$2,922,335

[1] Calendar year. [2] Ten months ending Oct. 31, 1920.

Licorice root—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	Free	66,144,390	$1,141,384	.....	$0.017	.....
1908	....do	109,359,556	1,864,508	.....	.011	.....
1909	....do	97,742,776	1,628,894	.....	.017	.....
1910	....do	82,209,935	1,365,576	.....	.017	.....
1911	....do	126,140,623	2,060,571	.....	.016	.....
1912	....do	74,680,270	1,309,819	.....	.018	.....
1913	....do	105,032,429	1,806,756	.....	.017	.....
1914	....do	32,377,106	611,907	.....	.019	.....
	¼ cent per pound	54,377,139	914,150	$135,942	.017	14.87
1915	....do	82,289,410	1,557,442	205,723	.018	13.21
1916	....do	52,784,042	1,792,573	131,960	.033	7.36
1917	....do	59,398,644	2,189,441	148,496	.036	6.78
1918	....do	27,051,021	1,863,886	67,627	.068	3.63
1919	....do	42,644,661	3,426,007	106,612	.080	3.11
Calendar years:						
1918	.....	27,068,489	1,985,796	67,671	.073	3.41
1919	.....	49,487,602	3,815,989	123,719	.077	3.24
1920[1]	.....	27,417,575	1,430,503	68,544	.052	4.08

[1] 6 months.

Licorice, Spanish, in bales, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912 [1]	$0.04	-$0.04½	
Apr. 1, 1912 [1]	.04½	- .05½	
July 1, 1912 [1]	.04½	- .05½	
Sept. 30, 1912 [1]	.04½	- .05½	
Dec. 30, 1912 [1]	.04½	- .05½	
Mar. 31, 1913 [1]	.04½	- .05½	
June 30, 1913 [1]	.04½	- .05½	
Sept. 29, 1913 [1]	.04½	- .05½	
Dec. 29, 1913 [1]	.04½	- .05½	
Mar. 30, 1914 [1]	.04½	- .05½	
June 29, 1914 [1]	.04½	- .05½	
August, 1914	.04½	- .05½	
January, 1915	.05	- .07	
April, 1915	.06	- .07	
July, 1915	[2] .12	- .13	
October, 1915	[2] .12	- .13	
January, 1916	[2] .12	- .13	
April, 1916	[2] .20	- —	
July, 1916	.22	- .27	
October, 1916	$0.15	-$0.20	
Jan. 1, 1917	.16	- .18	
Apr. 2, 1917	.18	- .19	
July 2, 1917	.18	- .19	
Oct. 1, 1917	.18	- .19	
Dec. 31, 1917	.19	- .20	
January, 1918	.19	- .20	
April, 1918	.21	- .23	
July, 1918	.30	- .35	
October, 1918	.30	- .32	
January, 1919	.27	- .28	
April, 1919	.22	- .24	
July, 1919	.18	- .19	
October, 1919	.18	- .19	
January, 1920	.18	- .19	
April, 1920	.15	- .18	
July, 1920	.13	- .14	
October, 1920	.13	- .14	

[1] "Spanish" omitted.

[2] Nominal.

Licorice, selected, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

January, 1912 [1]	$0.07½	-$0.09	
Apr. 1, 1912 [1]	.07½	- .08½	
July 1, 1912 [1]	.07½	- .08½	
Sept. 30, 1912 [1]	.07½	- .08½	
Dec. 20, 1912 [1]	.11	- .12	
Mar. 31, 1913 [1]	.09	- .11	
June 30, 1913 [1]	.09	- .11	
Sept. 29, 1913 [1]	.05	- .11	
Dec. 29, 1913 [1]	.09	- .11	
Mar. 30, 1914 [1]	.09	- .11	
June 29, 1914 [1]	.09	- .11	
Aug. 29, 1914 [1]	.09	- .11	
January, 1915	.12	- .14	
April, 1915	.13	- .14	
July, 1915	.13	- .14	
October, 1915	.14	- .15	
January, 1916	.15	- .16	
April, 1916	.25	- —	
July, 1916	.22	- .27	
October, 1916	$0.25	-$0.26	
Jan. 1, 1917	.25	- .26	
Apr. 2, 1917	.22	- .24	
July 2, 1917	.23	- .25	
Oct. 1, 1917	.22	- .24	
Dec. 31, 1917	.22	- .24	
January, 1918	.21	- .23	
April, 1918	.22	- .24	
July, 1918	.31	- .35	
October, 1918	.32	- .34	
January, 1919	.31	- .32	
April, 1919	.28	- .30	
July, 1919	.27	- .28	
October, 1919	.27	- .28	
January, 1920	[2]		
April, 1920	[2]		
July, 1920	.33	- .35	
October, 1920	.35	- .37	

[1] Bundles.

[2] Nominal.

Licorice, Russian, peeled and cut, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1917	$0.55	-$0.70	
Apr. 2, 1917	.65	- 1.00	
July 2, 1917	.65	- 1.00	
Oct. 1, 1917	.65	- 1.00	
Dec. 31, 1917 [1]	.65	- 1.00	
Jan., 1918	$0.65	-$1.00	
Apr., 1918	.90	- 1.00	
July, 1918	.75	- .90	
Oct., 1918	.85	- .90	
Jan., 1919	.75	- .80	

[1] Nominal.

Licorice, Syrian, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1917	$0.16	-$0.18	
Apr. 2, 1917	.17	- .18	
July 2, 1917	.17	- .18	
Oct. 1, 1917	.17	- .18	
Dec. 31, 1917	$0.17	-$0.18	
Jan., 1918	.17	- .18	
Apr., 1918	[1]		
July, 1918	[1]		

[1] Nominal.

Licorice, powdered, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1917	$0.20	-$0.21	
Apr. 2, 1917	.23	- .24	
July 2, 1917	.24	- .26	
Oct. 1, 1917	.24	- .26	
Dec. 31, 1917	.24	- .26	
Jan., 1918	.24	- .26	
Apr., 1918	.27	- .29	
July, 1918	.33	- .34	
Oct., 1918	.33	- .35	
Jan., 1919	$0.28	-$0.30	
Apr., 1919	.26	- .27	
July, 1919	.23	- .25	
Oct., 1919	.24	- .26	
Jan., 1920	.24	- .26	
Apr., 1920	.21	- .23	
July, 1920	.19	- .20	
Oct., 1920	.19	- .20	

Licorice root—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem
1883	544	Licorice root, unground	Free.
1883	94	All * * * roots * * * not edible but which have been advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially enumerated or provided for * * *.	10 per cent ad valorem.
1890	632	Licorice root, unground	Free.
1890	24	Drugs, such as * * * roots, * * * not edible * * * advanced in value or condition by refining or grinding or by other process of manufacture, and not specially enumerated or provided for * * *.	10 per cent ad valorem.
1894	534	Licorice root, unground	Free.
1894	16½	Drugs, such as * * * roots * * * not edible * * * advanced in value or condition by refining or grinding or by other process of manufacture, and not specially provided for * * *.	10 per cent ad valorem.
1897	598	Licorice root, unground	Free.
1897	20	Drugs, such as * * * roots * * * which are drugs and not edible, but which are advanced in value or condition by refining, grinding, or other process, and not specially provided for * * *.	¼ of 1 cent per pound, plus 10 per cent ad valorem.
1909	611	Licorice root, unground	Free.
1909	20	Drugs, such as * * * roots * * * which are natural and uncompounded drugs and not edible, and not specially provided for * * * but which are advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the drugs, and the prevention of decay or deterioration pending manufacture * * *. *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be classified for duty under this paragraph.	¼ of 1 cent per pound, plus 10 per cent ad valorem.
1913	39	* * * licorice root * * *	¼ of 1 cent per pound.

LICORICE EXTRACTS.

SUMMARY.

Description.—Licorice extract is a dry decoction of licorice root. It is used in pharmacy and in the manufacture of chewing tobacco.

Domestic production.—Licorice extract is extensively manufactured in America from imported licorice root. It is prepared chiefly by tobacco manufacturers for their own use. Very little of the American product is used in pharmacy. Taking the average extract content of licorice root at 20 per cent (United States Pharmacopoeia, IX), average annual imports for 1909–1917, 85,225,819 pounds, is equivalent to 17,045,164 pounds of licorice extract.

Foreign production.—Licorice extract is extensively produced in Italy. Lesser amounts are manufactured in Russia, Spain, Turkey, Greece, and other European countries. European production depends largely on cheap hand labor, whereas American factories, as well as some owned by British interests, chiefly in Russia, employ a higher type of mechanical apparatus than that used in Italy and Spain and are, to a corresponding extent, less dependent on hand labor. Italian exports for the years 1909–1916 averaged 2,927,488 pounds annually. French exports for the same years averaged 1,086,454 pounds. Spanish exports for this period are still smaller, averaging 1,069,189 pounds. Principal customers of Italy before the war were the United Kingdom and Belgium, which countries also took a large share of French licorice extract. Spanish exports went chiefly to the United States and France.

Imports.—American imports of licorice paste are contributed chiefly by Spain. Much smaller amounts are furnished by Italy and still less by France. Imported licorice paste is said to be of a higher grade than that commonly produced in the United States and is largely used in pharmacy. Under the new tariff rate of 1914 imports have increased considerably, and larger amounts are believed to have been used in tobacco manufacture. Trade in licorice paste has also grown at the expense of that of licorice owing to the greater bulk of the latter and the shipping restrictions imposed upon it under war conditions. Imports in recent years have been influenced considerably by the changing tariff rates. For the year 1909, at 4½ cents per pound, 520,446 pounds, valued at $62,907, entered. For the years 1910–1913, at 2½ cents per pound, the average annual amount is 820,205 pounds and the average annual value $105,706. In the years 1914–1918, at 1 cent per pound, the annual averages increased to 1,244,404 pounds and $192,902. In these calculations small portions of years for the years 1910 and 1914 during which the previous rate was in effect have been omitted, as have also small amounts imported for manufacture in bond on which duty was remitted.

Revenues.—Revenues have, generally speaking, decreased with the diminution in rate. For the years 1909–1913 they average $21,088; for the years 1914–1918, $10,872.

Prices.—Declared values of imports for recent years reached a maximum of 31.3 cents per pound in 1918. For the years 1909–1917 they varied from 11.6 cents per pound to 21.9 cents. American wholesale prices of licorice extract are not quoted prior to 1916. Since July, 1916, they have risen from 29 cents and 48 cents per pound to 90 cents per pound (Dec. 30, 1918).

Tariff history.—The tariff act of 1913 contains the following provision:

40. Licorice, extracts of, in pastes, rolls, or other forms, 1 cent per pound.

Licorice extracts and pastes have also been dutiable under recent tariffs. Following are the rates since 1883, in cents per pound:

1883	7½	1897	4½
1890	5½	1909	2½
1894	5		

The specific rates of recent years have corresponded to an ad valorem rate ranging from 38.8 per cent in the earlier part of 1910 to 3.20 per cent in 1918. Under the act of 1913 the ad valorem rate has never exceeded 7.74 per cent.

General Information.

Description.—The commercial extract of licorice is a decoction of the root, either fresh or dried, evaporated to a proper consistency, and molded or formed into various shapes. Imports of licorice extracts are chiefly from Italy, Spain, Russia, and Greece.

Substitutes and adulterants.—Before the scarcity of licorice caused by the war, no attempt was made to provide substitutes. Recently certain tobacco manufacturing firms are understood to be using a substitute containing only a small amount of licorice. The composition of this substance has not been made known.

As adulterants gum, dextrin, starch, gelatin, ground licorice root, etc., occur.

Varieties.—Licorice paste, mass, or crude licorice, the most common form in the United States, is, as the name implies, a pasty mass, occurring in commerce in cases ranging in weight from 250 to 400 pounds.

Stick or roll licorice occurs in flattened cylindrical rolls of varying size, averaging 6 to 9 inches long and ½ to 1 inch thick. This form is more common abroad, and its manufacture is of little importance in this country.

Other forms are known in trade, but they are of extremely minor importance.

Manufacture.—Licorice extracts are manufactured in nearly all countries where licorice root is commercially grown or gathered. Italy leads in this manufacture; Spain, Turkey, Greece, and Russia are also important. The United States manufactures by far the larger part of the extract consumed here, importing the root for this purpose.

The process of manufacture is essentially the same in all countries. The root is worked either fresh or dry; it is claimed that stick licorice which will remain hard and stiff without addition of foreign matter can be prepared only from the fresh root. That made from dried

root softens on standing, and bends instead of breaking sharply. The reason for this difference of character is unknown.

The root is used either peeled or unpeeled. The best extract is made from the unpeeled root.

The root is washed and ground into a mealy mass by machinery; then cooked in water about 15 hours, or until the water is saturated. The resulting decoction is allowed to settle and is decanted or strained into large caldrons, where it is boiled till it reaches a proper consistence. Formerly copper kettles were used, but owing to the presence of appreciable amounts of copper in the finished product, iron is now more frequently employed. In British factories (which include most of those operating in Russia) and also more especially in the plants of the United States, a higher type of apparatus, is employed. Extraction is frequently carried out by steam and evaporation is conducted in a vacuum evaporator. The operations are carried out in a more careful manner, and the resulting output is accordingly of a superior quality. In paste manufacture the hot thickened juice is run into the shipping cases and allowed to cool there. In the Italian factories the warm mass is formed by hand into small cakes or into rolls, which are allowed to dry and harden two or three months on iron plates. It is not an uncommon practice to add sugar, gum, starch, or perhaps glue to obviate the deliquescent tendency of the licorice. Each stick is stamped with the maker's name or trade-mark and packed in cases with laurel or oak leaves to prevent the sticks from adhering.

Italian licorice manufacture is carried on by both men and women, and is of a seasonal character, from the middle of December to the beginning of May.

"Pure extract of glycyrryiza," "U. S. P.," and "refined licorice," so-called, are standardized or processed preparations used in pharmacy.

Uses.—Licorice paste in America is used wholly in the manufacture of chewing tobacco. This product has been considered indispensable in this connection.

Licorice rolls and sticks are used for pharmacy and confectionery.

The commercial extract of licorice is recognized in the United States and most other pharmacopœias, but it is customary in these authorities to give formulæ for standardizing the product or preparing a standardized "pure extract" from the root.

In pharmacy licorice extract is a useful demulcent, much employed in cough mixtures, pills, and troches, and to modify or mask the taste of more valuable therapeutic agents.

Disturbances.—Excerpts from A Review of the Natural Dyeuation, by C. R. Delaney, in Oil, Paint, and Drug Reporter, y 27, 1918, page 12.

> more, Md., and Camden, N. J., there were two enormous extract works ring licorice, which was then imported from Southern Russia and the Turk- . Promptly upon closing the Dardanelles shipments of the raw material rely ceased, and it is only with the utmost difficulty that the precarious ecured from Russia, Spain, and Italy. * * * These two plants im- ad their attention drawn to the possibilities of the manufacture of logwood ..ract, both being on seaports, and the Baltimore plant being nearer to the source of raw material supply than any other factory * * * these two concerns, with * * * a third at Lynchburg, Va., immediately shot into prominen[3,668] owerful factors in the logwood extract situation.

Exports of licorice juice from France.

Country.	1909		1910		1911	
	Quantity.	Value	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	250,443	$32,887	214,728	$28,197	276,457	$36,303
Belgium	193,343	25,389	201,060	26,402	259,481	34,074
United States	2,646	347				
Germany	126,544	16,618	141,756	18,615	142,858	18,760
Sweden	97,664	12,825	93,034	12,217	63,272	8,309
Norway	101,632	13,346	83,995	11,030	74,956	9,843
All other	246,915	32,424	506,176	66,469	630,736	82,826
Total	1,019,187	133,836	1,240,749	162,930	1,447,760	190,115

Country.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	269,843	$35,435	166,006	$21,799	68,784	$9,032
Belgium	229,940	30,195	200,178	26,287	101,412	13,317
Germany	141,094	18,528	128,969	16,936	62,170	8,164
Sweden	96,561	12,680	72,311	9,496	78,925	10,364
Norway	86,641	11,377	99,427	13,056	89,066	11,696
All other	473,107	62,127	575,842	75,617	435,628	57,205
Total	1,297,186	170,342	1,242,733	163,191	835,985	109,778

Country.	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United Kingdom	228,176	.....	427,692	.....	189,155	.....
Belgium	6,614	.....	.....	.....	.....	.....
United States	.....	.....	661	.....	.....	.....
Sweden	16,093	.....	61,949	.....	60,406	.....
Norway	119,710	.....	261,906	.....	31,746	.....
All other	309,085	.....	176,149	.....	222,224	.....
Total	679,678	$238,008	928,357	$426,680	503,531	$247,855

Exports of licorice juice from Italy.

Country.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	156,968	$20,612	181,659	$22,265	149,472	$18,320
United Kingdom	655,427	86,068	601,856	73,765	724,432	88,788
Germany	229,719	30,166	202,823	24,858	209,217	25,642
Belgium	566,582	74,402	432,983	53,067	473,548	58,039
United States	75,618	9,930	93,034	11,402	83,113	10,186
All other	590,392	77,528	776,901	95,219	1,026,241	125,778
Total	2,274,706	298,706	2,289,256	280,576	2,666,023	326,753

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Exports of licorice juice from Italy—Continued.

Country.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	106,262	$13,024	74,075	$9,079	113,978	$13,969
United Kingdom	681,662	83,546	538,363	65,983	478,398	58,633
Germany	315,699	38,692	358,027	43,880	465,832	57,093
Belgium	428,133	52,473	408,733	50,095	268,520	32,910
United States	98,325	12,051	44,092	5,404	72,972	8,944
All other	928,357	113,781	785,499	96,272	1,067,088	133,236
Total	2,558,438	313,567	2,208,789	270,713	2,486,788	304,785

Country.	1915		1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
France	1,406,755	$209,361	1,241,851	.....	292,981	.....	404,324	.....
United Kingdom	1,131,401	168,381	1,392,646	.....	1,322,980	.....	1,847,234	.....
Germany	483,248	71,920	.....	.....	.....	.....	.....	.....
United States	92,373	13,747	391,837	.....	124,560	.....	57,761	.....
All other	1,171,965	174,418	1,633,829	.....	2,008,622	.....	620,374	.....
Total	4,285,742	637,827	4,650,163	$1,221,285	3,749,143	$2,297,511	2,929,693	$1,795,344

Exports of licorice extract paste from Spain.

Country.	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United States	19,952	$2,271	137,236	$15,619	618,324	$70,370
France	683,708	77,811	985,721	112,182	463,316	52,729
All other	81,323	11,513	70,525	8,026	117,979	13,419
Total	784,983	91,595	1,193,482	135,827	1,199,619	136,518

Country.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
United States	540,034	$61,460	497,168	$57,585	334,356	$38,052
France	406,286	46,239	385,071	43,824	533,293	60,693
All other	26,920	3,063	48,545	4,521	77,381	8,807
Total	973,240	110,762	930,784	105,930	945,030	107,552

Country.	1915		1916	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
United States	656,162	$74,676	689,804	$78,505
France	483,034	54,973	403,224	45,890
All other	58,512	6,729	235,640	26,817
Total	1,197,708	136,378	1,328,668	151,212

Licorice, extracts of, in pastes, rolls, or other forms—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1907	4½ cents per pound.	692,739	$77,984	$31,173	$0.113	39.96
1908	....do....	609,742	72,120	27,438	.118	38.05
1909	....do....	520,446	62,907	23,420	.121	37.23
1910	....do....	128,562	14,913	5,785	.116	38.80
1910	2½ cents per pound.	714,638	88,356	17,865	.124	20.22
1911	....do....	835,268	115,531	20,881	.138	18.07
1912	....do....	934,692	117,114	23,367	.125	19.95
1913	....do....	796,222	101,823	19,905	.128	19.55
1914	....do....	139,357	18,045	3,483	.129	19.31
1914	1 cent per pound..	786,136	101,596	7,861	.129	7.74
1915	....do....	1,055,646	149,302	10,556	.141	7.07
1916	....do....	1,702,927	230,129	17,029	.135	7.40
1917	....do....	1,156,300	253,671	11,563	.219	4.56
1918	....do....	734,876	229,812	7,348	.312	3.20
1919	....do....	413,848	213,028	4,138	.515	1.94
Calendar years:						
1918	....do....	399,146	159,698	3,991	.400	2.58
1919	....do....	871,178	581,909	8,711	.667	1.50
1920 [1]	....do....	576,636	358,102	5,766	.621	1.61

[1] 6 months.

Licorice, prices, cents per pound, wholesale, in New York.

[From Oil, Paint, and Drug Reporter.]

Year.	In bales (Spanish).				Selected.			
	January.	April.	July.	October.	January.	April.	July.	October.
1915	5- 7	.....	.....	.....	12-14	.....	.....	.....
1916	12-13	.....	.....	.....	15-16	.....	.....	.....
1917	16-18	.....	.....	.....	25-26	.....	.....	.....
1918	19-20	21-25	30-35	30-32	21-23	22-24	31-35	32-34
1919	27-28	22-24	18-19	18-19	31-32	28-30	27-28	27-28
1920	18-19	15-18	13-14	13-14	[1]	[1]	33-35	35-37

Year.	Powdered.				Stick (Corigliano).			
	January.	April.	July.	October.	January.	April.	July.	October.
1918	.....	.....	.....	.....	50 -55	[1]	$2½-83	$2½-83
1919	140-145	75-100	90-95	90-95	$2½-83	$2½-83	$2½-83	$2½-83
1920	90- 95	80- 90	.....	90-95	$2½-83	80 -82	50 -52	50 -52

Year.	Powdered root.				Russian and peeled.			
	January.	April.	July.	October.	January.	April.	July.	October.
1918	24-26	27-29	33-34	33-35	65-1.00	90-1.00	75-90	85-90
1919	24-26	26-27	23-25	24-26	.....	.....	.....	.....
1920	24-26	23-24	19-20	19-20	.....	.....	.....	.....

Year.	Licorice powder compound.				Extract mass.			
	January.	April.	July.	October.	January.	April.	July.	October.
1918	25-30	25-30	30-32	25-30	70-72	70-72	85-90	95-1.00
1919	25-30	25-30	25-30	25-30	90	90	70-75	70- 75
1920	24-26	23-24	21-23	21-23	54-56	50-52	42-43	38- 39

[1] Nominal.

Licorice, extracts of—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	24	Licorice, paste or roll	7½ cents per pound.
1883	24	Licorice juice	3 cents per pound.
1890	33	Licorice, extracts of, in paste, rolls, or other forms	5½ cents per pound.
1894	23	----do	5 cents per pound.
1897	29	----do	4½ cents per pound.
1909	29	----do	2½ cents per pound.
1913	40	----do	1 cent per pound.

SARSAPARILLA.

SUMMARY.

Description.—Sarsaparilla root is a crude botanical drug used chiefly in proprietary medicine, e. g., blood purifiers and tonics. It is not highly valued by modern therapeutic authorities.

Domestic production.—Sarsaparilla is not produced within the United States. Several plants of the southern Appalachians that furnish substitutes of minor commercial importance may be mentioned: Bamboo, briar root, and so-called American sarsaparilla, which is botanically distinct from the imported article.

Foreign production.—Sarsaparilla is chiefly derived from wild plants growing in the forests of Mexico, Central America, and northern South America. Small amounts are cultivated in Jamaica and Ceylon, but the products of these localities do not enter American commerce.

Imports.—American imports of sarsaparilla have decreased considerably in recent years. In 1909, 570,124 pounds, valued at $52,937, were imported. Imports for 1918 were 110,709 pounds, valued at $31,454. The annual average for the 10-year period (1909–1918) is 328,748 pounds and the average value $41,064. The recent diminution may probably be attributed to decreasing medicinal repute of the article and to disturbances of trade and traffic rather than to the imposition of duty by the tariff act of 1913.

Revenue.—Since the imposition of the duty of 1 cent per pound in 1913, sarsaparilla has yielded an average annual revenue of $1,903.

Prices.—Declared values of imports have ranged from $9\frac{3}{10}$ cents per pound in 1909 to $28\frac{4}{10}$ cents in 1918, the latter figure being double that of any year previously reported. New York wholesale prices of Mexican sarsaparilla have been very variable in recent years. Since January, 1912, they have varied from 9 to 12 cents per pound (April, 1915) to 60 cents per pound (December, 1917). The Honduras variety is usually quoted somewhat higher.

Tariff history.—The tariff act of 1913 contains the following provision: 39. "Leaves and roots: * * * sarsaparilla root, 1 cent per pound."

Previous tariffs since 1883 make no mention of this commodity, which was covered by general provisions for crude drugs analogous to the present paragraphs 27 and 477.

GENERAL INFORMATION.

Description.—Sarsaparilla is a crude botanical drug, composed of the dried root of *Smilax* medica Chamisso and Schlechtendal, known in commerce as Mexican sarsaparilla; of *Smilax officinalis Kunth*, or an undetermined species of *Smilax*, known in commerce as Honduras sarsaparilla; or *Smilax ornata Hooker filius*, known in commerce as Jamaica sarsaparilla (*Fam. Liliaceae*).

Among the sarsaparilla substitutes not of the genus *Smilax* is the root of an Agave, collected in Porto Rico, and called Porto Rico sarsaparilla. The root of a *Philodendron* was reported sold in Hamburg. The rhizome of *Carex arenaria* L (sandsedge German sarsaparilla) and that of *C. hirta L.* are similarly used. The roots of various ferns have been reported sold as sarsaparilla in England. The root of *Hemidesmus indicus* Br. (fam. Asclepiadeae), Indian sarsaparilla, found in India and Ceylon, is employed in native medicine, and was formerly official in England and India.

American substitutes are the rhizome of *Aralia nudicaulis*, American, wild, or Virginia sarsaparilla, and, to a less degree, that of *A. racemosa* (fam. Araliaceae).

Production.—By far the major portion of the sarsaparilla of commerce is a wild product. The plants are perennial climbers of great size, often climbing or running for hundreds of feet. The rootstocks run at or near the surface of the ground for great distances, giving off at their nodes fascicles of long, slender roots, which vary greatly in characters of growth in different species. The drug is collected by natives, who tear away the rootstocks when the ground is soft, and cut and dry the roots according to the custom of the respective locality, leaving some to perpetuate the plant. It is said that a full-grown plant may yield at the first cutting 32 to 64 pounds of roots, and that the plant in a couple of years may be cut again, but the yield will be much smaller.

Sarsaparilla is commercially cultivated at Peradeniyz, Ceylon, and in Jamaica. The Jamaican cultivated species is said to grow best in a light, well-drained, sandy loam, but the plant may be grown on alluvial flats, and on newly cleared land as long as the soil contains a large proportion of the original humus of the forest. The climate should be hot and moist, and, therefore, the cultivation is unsuited to the highlands. Propagation is by root suckers, layers, cuttings, or seed. Thorough cultivation is essential, and the vines must be staked or trellised. The first crop is gathered in from two to three years, and roots may be harvested each succeeding year. The first crop is said to yield as much as 20 pounds of dried roots per plant, or about 2,200 pounds per acre. The plant is usually grown in combination with other crops. When prices are high the gross return is said to be very great, but the market is very limited.

Ceylonese sarsaparilla, prior to 1911, brought 24 cents to 30 cents per pound in London.

The climatic requirements of sarsaparilla render it extremely unlikely that it could be commercially cultivated in the United States save perhaps in Florida or our insular possessions.

Uses.—Sarsaparilla was formerly official in all pharmacopœias, but has now been dropped by the British. Most pharmacopœias prefer the Honduras variety, and many allow "other undetermined species also."

Official preparations are compound fluid extract of sarsaparilla, compound sirup of sarsaparilla, fluid extract of sarsaparilla, compound decoction of sarsaparilla.

No drug in the materia medica has been the subject of so much discussion as to its efficacy as sarsaparilla. It is considered alterative, diuretic, diaphoretic, and tonic, but mostly believed to be of little or no service unless associated with other drugs, such as potassium iodide,

guaiac, sassafras, mezereum, etc. While when given alone it exercises little influence, in combination with mercury and the iodides it seems to increase their efficiency in the treatment of cases of obstinate syphilis which fail to yield to them alone. Sarsaparilla is largely used in domestic medicine as a "blood purifier" and is perhaps the least important ingredient of many patent medicines which bear its name.

It is also used somewhat in the manufacture of "soft drinks."

Sources.—Mexican sarsaparilla, also known as Vera Cruz or Tampico sarsaparilla, the dried root of *Smilax medica*, once thought valueless, but now considered the most valuable, grows in the Mexican Andes around Orizaba, Vera Cruz, etc. Honduras sarsaparilla, now most used in this country, is of uncertain botanical origin. A portion is generally supposed to be derived from *Smilax officinalis*, but most is the product of a species yet unnamed. It is grown in Honduras, Guatemala, Peru, Colombia, and Central America, and is imported from the Bay of Honduras. Jamaica sarsaparilla, the product of *S. ornata*, is collected chiefly in Costa Rica, and came to be called "Jamaica" through being exported through that Province. It is marketed chiefly in England; little comes to the United States. It was formerly the only species recognized in the British Pharmacopœia; now even this has been dropped.

Adulterants and substitutes.—The genus *Smilax* contains some 200 species, both of the Old and New Worlds. Many of these are medicinal, and are employed fraudulently or openly as substitutes for the official species. Roots of members of several unrelated genera which are more or less similar in appearance and contain similar medicinal properties are also termed "sarsaparilla," with various local definitives.

Several species of smilax are common in our Northeast. These are scarcely medicinal, though the root of one—*S. rotundifolia* L.—is somewhat used as an alterative. *S. pseudochina* and *S. tamnoides* of the Southern States are somewhat medicinal, but are of no present commercial importance. The medicinal properties of the Smilax species seem to increase with their southern range. Numerous species, whose botanical identity is often uncertain, occur mixed with the official and appear to have similar properties. Among these Para, Brazilian, Rio Negro, or Lisbon sarsaparilla, the root of *S. papyracea*, from northern Brazil and Guiana, often considered a variety of *S. officinalis*, but not recognized as such by the U. S. P., is perhaps the most important. Roots are taken also from *S. syphilitica* (Colombia), *S. glauca* (Mexico), and *S. utilis* (Jamaica). The latter—native or cultivated Jamaica, or *Roja Inglese*—is the only variety cultivated in the Western Hemisphere. Carcas sarsaparilla, occasionally exported from Venezuela, may be the same. Other tropical American species also occur.

Raiz de China de Mexico, Mexican China-root, which may be a species of *Smilax*, is a substitute used in Mexico.

Non-American species of *Smilax* of similar use in their native homes are *S. china* L. and *S. glabra Roxb.* (Radix chinae, or china root), of eastern Asia, including Japan; *S. ovalifolia Roxb.*, of India; *S. aspera* L., of southern Europe. None are important commercially. A drug said to be *S. officinalis* is cultivated in Ceylon and exported to London.

Sarsaparilla—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	570,124	$52,937		$0.093	
1910	do	560,858	59,786		.107	
1911	do	379,091	43,849		.116	
1912	do	452,917	51,428		.114	
1913	do	301,308	38,360		.127	
1914 [1]	do	71,228	8,447		.119	
1914 [2]	1 cent per pound	153,742	27,837	$1,537	.181	5.52
1915	do	250,178	36,055	2,501	.144	6.94
1916	do	291,276	41,489	2,912	.142	7.02
1917	do	146,047	18,994	1,460	.130	7.69
1918	do	110,709	31,454	1,107	.284	3.52
1919	do	221,946	58,126	2,219	.261	3.82

[1] Act of 1909, July 1 to Oct. 3, 1913. [2] Act of 1913, Oct. 4, 1913, to June 30, 1914.

Sarsaparilla, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

HONDURAS.

Jan. 1, 1912	[1] $0.29	Oct., 1915	$0.40–$0.45
Apr. 1, 1912	$0.27 –$0.30	Jan., 1916	.40– .45
July 1, 1912	.25 – .28	Apr., 1916	.40– .45
Sept. 30, 1912	.30 – .35	July, 1916	.38– .39
Dec. 30, 1912	.35 – .40	Oct., 1916	.38– .39
Mar. 31, 1913	.35 – .40	Jan. 1, 1917	.38– .39
June 30, 1913	.40	Apr. 2, 1917	.38– .39
Sept. 29, 1913	.40	July 2, 1917	.41– .42
Dec. 29, 1913	.42 – .44	Oct. 1, 1917	.43– .45
Mar. 30, 1914	.42 – .44	Jan. 5, 1918	.65– .75
June 29, 1914	.45 – .50	Apr. 1, 1918	.70– .75
Aug., 1914	.65 – .70	July 1, 1918	.70– .75
Jan., 1915	.48 – .50	Oct. 7, 1918	.80– .85
Apr., 1915	.42½– .45	Jan. 6, 1919	.80– .85
July, 1915	.40 – .45	Apr. 7, 1919	.80– .85
		July 7, 1919	.75– .80
		Oct. 6, 1919	.75– .80

MEXICAN.

	Cents		Cents.
Jan. 1, 1912	18½–19	Apr., 1916	11 –12
Apr. 1, 1912	13 –14½	July, 1916	12½–13
July 1, 1912	13 –14	Oct., 1916	10½–11
Sept. 30, 1912	14 –16	Jan. 1, 1917	14 –15
Dec. 30, 1912	15½–16	Apr. 2, 1917	18½–19
Mar. 31, 1913	15½–16	July 2, 1917	25 –26
June 30, 1913	16 –17	Oct. 1, 1917	37 –39
Sept. 29, 1913	17 –18	Dec. 31, 1917	[1] 60
Dec. 29, 1913	28 –30	Jan. 5, 1918	[1] 60
Mar. 30, 1914	20 –22	Apr. 1, 1918	[1] 70
June 29, 1914	35 –45	July 1, 1918	65 –70
Aug., 1914	30 –32	Oct. 7, 1918	50 –52
Jan., 1915	10 –12	Jan. 6, 1919	32 –38
Apr., 1915	9 –10	Apr. 7, 1919	30 –35
July, 1915	15 –16	July 7, 1919	45 –50
Oct., 1915	13 –14	Oct. 6, 1919	50 –52
Jan., 1916	12 –13		

[1] Nominal.

Sarsaparilla root—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	636	Drugs * * * roots * * * not edible * * * in a crude state * * * not advanced * * * and not specially enumerated or provided for * * *.	Free.
1883	94	All * * * roots * * * not edible but which have been advanced in value or condition by refining or grinding, or by other process of manufacture, and not specially enumerated or provided for.	10 per centum ad valorem.
1890	560	Drugs, such as * * * roots * * * not edible * * * in a crude state, * * * not advanced * * * not specially provided for * * *.	Free.
1890	24	Drugs, such as * * * roots * * * not edible * * * advanced in value or condition by refining or grinding or by other process of manufacture, and not specially enumerated or provided for * * *.	10 per centum ad valorem.
1894	470	Drugs, such as * * * roots, * * * drugs which are not edible * * * not * * * advanced * * * not specially provided for * * *.	Free.
1894	16½	Drugs, such as * * * roots * * * not edible * * * advanced in value or condition by refining or grinding or by other process of manufacture, and not specially provided for * * *.	10 per centum.
1897	548	Drugs, such as * * * roots * * * which are drugs and not edible * * * in a crude state * * * not advanced * * * not specially provided for * * *.	Free.
1897	20	Drugs, such as * * * roots * * * which are drugs and not edible, but which are advanced in value or condition by refining, grinding, or other process, and not specially provided for * * *.	⅛ of 1 cent per pound plus 10 per cent ad valorem.
1909	559	Drugs, such as * * * roots * * * which are natural and uncompounded drugs and not edible and not specially provided for * * * in a crude state, not advanced * * * : *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be admitted free of duty under this paragraph.	Free.
1909	20	Drugs, such as * * * roots * * * which are natural and uncompounded drugs and not edible, and not specially provided for * * * but which are advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the drugs, and the prevention of decay or deterioration pending manufacture * * * : *Provided*, That no article containing alcohol, or in the preparation of which alcohol is used, shall be classified for duty under this paragraph.	⅛ of 1 cent per pound plus 10 per centum ad valorem.
1913	39	* * * sarsaparilla root * * *.....	1 cent per pound.

COURT AND TREASURY DECISIONS.

A preparation consisting principally of a decoction of sarsaparilla admitted free as "similar" to lemonade and soda water, within paragraph 555 of the act of 1894. T. D. 17479, G. A. 3618.

LICORICE EXTRACT.

[Paragraph 40, act of 1913, 1 cent per pound. See paragraph 39, *supra*.]

CITRATE OF LIME.

[Paragraph 41, act of 1913, 1 cent per pound. See paragraph 1.]

MAGNESIUM COMPOUNDS.

[Paragraph 42, act of 1913.]

SUMMARY.

Description.—The most important compounds of magnesium are magnesia, or the oxide of magnesium; epsom salts, or magnesium sulphate; magnesium carbonate; and magnesium chloride.

The raw material from which most of these is derived is the natural carbonate of magnesia, or magnesite. Prior to 1914 nearly all the magnesite was imported from Europe, but since the shutting off of a large part of the foreign supply by the war the deposits in the United States have been rapidly developed and now supply most of that used.

Uses.—Magnesium compounds are used principally in the manufacture of refractories, for the preparation of the so-called Sorel cements, in medicine, and in the textile and paper industries.

Domestic production.—The United States produces the largest part of the magnesite it consumes and also most of the manufactured compounds. The crude magnesite produced and sold or treated in the United States in 1917 amounted to 316,838 short tons with a total value of $2,899,818, about two-thirds of which came from California. No late figures for the production of magnesium compounds are available, but in 1914 the total production of magnesium sulphate was 29,265,115 pounds. The production has probably increased since then. The United States also produces a very good grade of magnesium chloride.

Imports.—Before the war most of the magnesite and a large part of the magnesium salts used in this country was imported from Europe. The magnesite came principally from Austria-Hungary and Greece and the salts from Germany. Since the beginning of the war and the development of the domestic supplies the imports have fallen off greatly.

Exports.—No exports of magnesia or magnesium compounds are shown.

Prices.—The prices of magnesite and magnesium compounds have increased greatly since the beginning of the war, especially since the beginning of 1917. The prices remained fairly stationary during 1918.

Tariff history.—Magnesite has been on the free list since 1883, but the compounds of magnesium have always been dutiable, though the rates have varied.

General Information.

MAGNESITE.

Magnesite.—The natural carbonate of magnesia is the raw material for the manufacture of most other magnesium compounds.

The principal use for the crude, uncalcined magnesite is for the production of carbon dioxide on a large scale, which use, however, is decreasing rather than increasing owing to the fact that it can not be carried out at a profit unless the residue of burned magnesite can be sold, which is not always the case, as it is often impure and not sufficiently burned to be sold as "calcined" magnesite.

The calcined magnesite is known as "caustic calcined magnesite" or "dead burned magnesite," according to the degree to which it has been burned. The "caustic calcined" still contains 1 to 2 per cent of carbon dioxide, while the "dead burned" has been so strongly calcined that practically all the carbon dioxide and water have been driven off.

Domestic production and imports.—Up to 1916 most of the magnesite used in the United States was imported, principally from Austria-Hungary, with less amounts from Greece, Netherlands, and Germany. Magnesite was shipped from Greece by tramp steamers to Holland, where it was calcined and packed and later reshipped in tramp steamers to this country. Practically all magnesium chloride was shipped from Germany in the same way. It was shipped mostly as ballast, arriving in poor condition, and there was no uniformity of the material.

By the end of 1914 nearly all the stocks of magnesite and magnesium chloride in this country were exhausted and the industry came to a standstill until domestic sources could be developed. During 1916 the domestic production increased greatly due to the fact that the imports had declined and to an increased demand for refractory magnesite products. California now supplies a high grade of magnesite and Michigan of magnesium chloride, both of which are shipped in accordance with standard specifications.

In 1913, before the beginning of the war in Europe, 19,264,000 pounds of raw magnesite were produced, while 26,480,000 pounds of raw and 334,188,000 pounds of calcined magnesite were imported. In 1916 the domestic production increased to 309,948,000 pounds, while the imports had decreased to 150,690,000 pounds of raw magnesite and 18,540,000 pounds of the calcined.

In 1916 practically all the magnesite produced[1] in the United States came from California, though late in that year Washington began making shipments, and in 1917 these two States produced the bulk of that mined in this country.

Exports.—No exports of magnesite are shown, though small quantities are probably exported to Canada.

[1] Figures from U. S. Geological Survey.

Crude magnesite—Production in the United States.

[From mineral sources.]

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Pounds.			*Pounds.*	
1910	24,886,000	$74,658	1914	22,586,000	$124,223
1911	18,750,000	75,000	1915	60,998,000	274,491
1912	21,024,000	84,096	1916	309,948,000	1,393,693
1913	19,264,000	77,056	1917	633,276,000	2,899,818

MAGNESIA.

Magnesia, or the oxide of magnesium, is obtained in the crude form by heating the natural magnesite. Pure magnesia may be made by igniting the pure carbonate or nitrate of magnesia.

Uses.—The impure caustic calcined magnesia is used largely in the manufacture of Sorel, or oxychloride cement, and in preparing liquor in which wood pulp is digested for the manufacture of paper. The dead burned magnesia is used for making refractories and in the manufacture of steel by the open-hearth process. Purified magnesia is used in medicine.

The largest part of the crude magnesia consumed in the United States is used in the manufacture of steel and copper, though the exact amount is difficult to estimate. The magnesia cement industry is large and consumes a considerable proportion, but high prices for calcined magnesia and the uncertainty of quality have limited it to some extent. The use of magnesia for preparing liquors for paper making is confined principally to the Pacific coast near the source of the magnesite.

Domestic production and imports.—Figures for the domestic production of magnesia are not available, but most of that consumed is of domestic manufacture. Before the war large amounts of crude magnesia and some pure magnesia were imported, but the amounts have fallen off rapidly (see tables on pp. 9 and 9a). In 1917, 56,656 pounds of purified magnesia for medicinal purposes were imported, which was a considerable decrease over 1915, when the amount was 145,806 pounds.

Exports.—No exports of magnesia are listed, but small amounts are exported to Canada.

MAGNESIA CEMENTS.

If "caustic calcined" magnesite is mixed with magnesium chloride or calcium chloride, it sets after a short time to a very hard, durable cement, known as Sorel, or oxychloride cement. It is also known under trade names, such as "lignolite," "xylolite," etc.

The composition of the cement varies, but in all cases it consists of a mixture of caustic calcined magnesia, magnesium chloride, and some inert substance as sawdust, or infusorial earth. Such a cement may be made by mixing 100 parts of finely ground caustic calcined magnesia, freshly heated to redness, with 300 parts of sawdust or infusorial earth and adding 713 parts of a concentrated solution of magnesium chloride. This paste should be stirred continuously for some hours so that the mass sets almost to a jelly without a separation

of the constituents. The maximum hardness is attained only after exposure to air for two or three weeks. Various coloring materials may be added to the mixture before it hardens.

The cement is used for flooring, for the making of artificial marble, and wherever a tile finish is desired. Being a nonconductor of electricity, it may be used for the manufacture of switchboards and similar articles. Its use in stucco work is gaining in importance, especially in California. It is reported that magnesia cement has been used by the Germans for gun emplacements because it sets quickly and attains great strength sooner than Portland cement.

CARBONATE OF MAGNESIA.

Carbonate of magnesia is used in medicine, for the preparation of other pure magnesium compounds, in tooth powders, in face powders, in metal polishes, and is sometimes mixed with other pigments in paints. Combined with magnesium chloride dissolved in water it is sometimes used as a paint for fire-retarding purposes. Another use is as a nonconductor of heat in coverings for steam pipes. For this use it is usually mixed with asbestos fiber.

It is obtained in pure form by treating a soluble magnesium salt with sodium carbonate. Magnesium carbonate may also be formed by heating magnesia with sodium bicarbonate. This gives a basic carbonate known as "magnesia alba," which when heated with water in the presence of carbon dioxide gives the normal carbonate.

Domestic production and imports.—Figures for the domestic production of carbonate of magnesia are not available. Some is imported, but since the beginning of the war the imports have decreased (see table on p. 9). In 1914 the amount imported was 58,683 pounds, but in 1916 the imports dropped to about one-third that amount.

Exports.—No exports of magnesium carbonate are shown.

MAGNESIUM SULPHATE.

Sulphate of magnesia, known as Epsom salts, is used for sizing cotton goods, for weighting silk, paper, and leather; for dyeing; also in medicine. Probably the largest use for the purified magnesium sulphate is in the drug trade and in the manufacture of laxative mineral waters.

Manufacture.—Before the beginning of the European war large quantities of Epsom salts were manufactured from the kieserite of Stassfurt. The crude kieserite which is sparingly soluble is washed with water which removes the chlorides of magnesium and sodium. The kieserite powder thus remaining is packed in wooden molds where it sets to a compact mass containing 80–90 per cent of Epsom salts. This may be purified by dissolving in water and recrystallizing. Another method is to treat dolomite, or magnesite, with sulphuric acid. The calcium sulphate which separates is removed by filtration, the clear solution concentrated and the magnesium sulphate allowed to crystallize.

Magnesium sulphate is manufactured in Baltimore and Philadelphia from a siliceous magnesium hydroxide. The mineral is powdered and treated with sulphuric acid, dried and calcined at a red heat to convert any iron salts to ferric oxide. This is then dissolved in water

treated with sodium sulphide to remove the last traces of iron, the solution concentrated and the magnesium sulphate allowed to crystallize.

Domestic production and imports.—Late figures for the production of Epsom salts in the United States are not available but up to 1914 there was a gradual increase in the amount produced and no doubt the increase has continued since then. In 1914 the United States produced 29,265,115 pounds of magnesium sulphate and imported 13,559,599 pounds. After the beginning of the European war the imports decreased, and in 1917 amounted to only 54,200 pounds.

There are some natural deposits of magnesium sulphate in the Western United States now being worked which formerly were not able to compete with the imported product. It is reported that there was shipped from one of these deposits during the first half of 1918 from 120 to 300 tons of Epsom salts each month.

Exports.—No exports of magnesium sulphate are shown.

Foreign production.—Late figures for foreign production are not at present obtainable. Before the beginning of the European war Germany was the largest producer of Epsom salts, and exported large amounts. In 1905 Germany produced 131,190,080 pounds of Epsom salts and in 1913 exported 61,150,660 pounds. In 1908 Italy produced 5,331,200 pounds.

MAGNESIUM CHLORIDE.

Magnesium chloride is used in the manufacture of magnesia cements; as a filler for cotton and woolen goods; and for the manufacture of hydrochloric acid.

Manufacture.—Before the beginning of the European war Germany manufactured magnesium chloride from the mother liquor of the Stassfurt salts. These liquors, after the removal of the potassium chloride, were evaporated in open pans to 42° Baumé, the salts which crystallized separated, and the solution remaining allowed to cool when it formed a solid crystalline mass.

In the United States magnesium chloride is obtained principally from salt brines, the bittern being utilized after the removal of the salt. Sea water bittern is also being made use of on the Pacific coast for the recovery of magnesium chloride. It is also made in this country by the solution of magnesite in hydrochloric acid.

Domestic production.—Figures for the domestic production, imports and exports are not available, but it is believed that none is exported.

Foreign production.—Complete figures for the foreign production are not obtainable. Germany was probably the largest producer before the war, the production in 1908 amounting to 67,200,000 pounds, a large part of which was exported. In 1909 Italy produced 3,252,480 pounds of magnesium chloride.

Sulphate of magnesia (Epsom salts)—Production in United States.

[From Federal census.]

1899		1904		1909		1914	
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Pounds. 9,239,809	$75,066	*Pounds.* 20,566,443	$215,088	*Pounds.* 21,621,297	$189,791	*Pounds.* 29,265,115	$296,999

Magnesia, carbonate of—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1908	3 cents per pound	101,393	$4,855	$3,041	$0.048	62.65
1909	do	42,325	2,509	1,269	.059	50.61
1910	do	56,016	3,679	1,680	.066	15.68
1911	do	43,666	2,628	1,309	.060	49.85
1912	do	51,991	2,923	1,556	.056	53.26
1913	do	77,190	3,811	2,315	.049	60.76
1914	do	9,431	925	282	.098	30.59
1914	1½ cents per pound	49,252	3,047	738	.062	24.25
1915	do	49,731	2,551	745	.051	29.21
1916	do	19,888	1,414	298	.071	21.10
1917	do	25,092	5,077	376	.202	7.41
1918	do	5,681	1,896	85	.333	4.49
Calendar years:						
1919	do	5,094	1,101	76	.215	6.94
1920[1]	do	14,250	1,341	213	.094	15.93

[1] Six months.

Magnesia, chloride of—Imports for consumption—Revenue.

Calendar years.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1918	15 per cent	13,076	$1,619	$243	$0.130	15
1919	do	11,200	537	81	.0479	15
1920[1]	do	208,507	3,112	467	.019	15

[1] Six months ending June 30, 1920.

Magnesia, sulphate of (Epsom salts)—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1908	¼ cent per pound	3,631,245	$12,094	$7,262	$0.003	60.05
1909	do	8,053,235	26,138	16,106	.003	61.62
1910	do	6,147,159	27,330	12,294	.004	44.98
1911	do	6,204,219	23,092	12,408	.004	53.73
1912	do	8,012,226	31,332	16,024	.004	51.15
1913	do	9,345,099	35,739	18,690	.004	52.30
1914	do	1,573,906	6,955	3,147	.004	45.26
1914	1/10 cent per pound	11,975,693	41,787	11,975	.003	28.66
1915	do	7,005,598	32,862	7,005	.004	21.32
1916	do	1,456,254	8,503	1,456	.005	17.13
1917	do	54,200	875	54	.016	6.19
1918	do	48,540	915	48	.018	5.30
Calendar year:						
1918	do	2,045	196	2	.095	1.05
1919	do	17,647	1,473	17	.083	1.20
1920[1]	do	649,124	7,566	649	.011	8.44

[1] Six months ending June 30, 1920.

Magnesia, calcined—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1908	7 cents per pound.	52,492	$8,623	$3,674	$0.164	42.61
1909	do	49,026	7,687	3,431	.157	44.64
1910	do	57,392	9,285	4,017	.162	43.27
1911	do	65,492	10,380	4,584	.158	44.17
1912	do	112,611	17,080	7,882	.152	46.15
1913	do	71,565	12,092	5,009	.169	41.43
1914	do	10,586	1,944	741	.184	38.12
1914	3½ cents per pound.	99,273	13,174	3,474	.133	26.37
1915	do	145,806	16,012	5,103	.109	31.87
1916	do	45,993	7,549	1,609	.164	21.32
1917	do	56,656	17,575	1,982	.310	11.28
1918	do	12,165	4,483	425	.368	9.50
Calendar year:						
1918	do	423	312	15	.737	4.74
1919	do	22,637	11,358	792	.501	6.98
1920 [1]	do	16,123	4,866	564	.301	11.59

[1] Six months ending June 30, 1920.

Magnesite, crude, not purified—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				
1908	Free	42,722,846	$141,992		$0.003	
1909	do	20,725,355	39,558		.002	
1910	do	34,175,514	108,623		.003	
1911	do	37,951,190	127,344		.003	
1912	do	29,415,095	88,482		.003	
1913	do	34,354,260	111,276		.003	
1914	do	21,590,605	46,611		.002	
1915	do	37,463,509	80,625		.002	
1916	do	101,591,459	281,620		.002	
1917	do	179,292,638	748,951		.004	
1918	do	18,532,767	104,947		.005	
Calendar year:						
1918	do	10,864,000	103,233		.0095	
1919	do	12,761,280	103,311		.0080	
1920 [1]	do	19,850,880	141,516		.0071	

[1] Six months ending June 30, 1920.

Magnesite, calcined, not purified—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				
1908	Free	146,860,775	$706,088		$0.004	
1909	do	186,961,370	871,383		.005	
1910	do	225,895,904	1,026,982		.005	
1911	do	296,225,507	1,362,120		.005	
1912	do	204,997,478	990,241		.005	
1913	do	345,322,155	1,731,443		.005	
1914	do	288,989,577	1,485,273		.005	
1915	do	125,893,407	751,766		.005	
1916	do	32,372,610	282,768		.008	
1917	do	9,448,817	182,037		.019	
1918	do	22,764,029	535,202		.023	
Calendar year:						
1918	do	38,097,920	824,022		.021	
1919	do	18,941,440	270,721		.014	
1920	do	17,801,280	186,137		.010	

[1] 6 months.

Magnesite, raw, prices per ton.

[From Oil, Paint, and Drug Reporter.]

Aug., 1914	$10.00–11.00	Jan., 1918	$30.00–35.00
Jan., 1915	10.00–11.00	Apr., 1918	30.00–35.00
Apr., 1915	10.00–11.00	July, 1918	30.00–35.00
July, 1915	10.00–11.00	Oct., 1918	30.00–35.00
Oct., 1915	10.00–11.00	Jan., 1919	30.00–35.00
Jan., 1916	10.00–11.00	Apr., 1919	30.00–35.00
Apr., 1916	10.00–11.00	July, 1919	30.00–35.00
July, 1916	10.00–11.00	Oct., 1919	30.00–35.00
Oct., 1916	10.00–11.00	Jan., 1920	30.00–35.00
Jan., 1917	10.00–11.00	Apr., 1920	30.00–35.00
Apr., 1917	30.00–35.00	July, 1920	30.00–35.00
July, 1917	30.00–35.00	Oct., 1920	30.00–35.00
Oct., 1917	30.00–35.00		

Magnesite, calcined, powdered, prices per ton.

[From Oil, Paint, and Drug Reporter.]

Aug., 1914	$30.00–35.00	Jan., 1918	$40.00–65.00
Jan., 1915	30.00–35.00	Apr., 1918	50.00–65.00
Apr., 1915	30.00 35 00	July, 1918	50.00–65.00
July, 1915	30.00–35.00	Oct., 1918	50.00–65.00
Oct., 1915	30.00–35.00	Jan., 1919	50.00–65.00
Jan., 1916	30.00–35.00	Apr., 1919	50.00–65.00
Apr., 1916	30.00–35.00	July, 1919	50.00–65.00
July, 1916	30.00–35.00	Oct., 1919	50.00–65.00
Oct., 1916	30.00–35.00	Jan., 1920	50.00–65.00
Jan., 1917	30.00–35.00	Apr., 1920	50.00–65.00
Apr., 1917	40.00–55.00	July, 1920	50.00–65.00
July, 1917	40.00–55.00	Oct., 1920	50.00–65.00
Oct., 1917	40.00–55.00		

Magnesia, calcined, prices cents per pound.

[From Oil, Paint, and Drug Reporter.]

January, 1918	$0.65–$0.75	July, 1919	$.60–$0.65
April, 1918	.60– .70	October, 1919	.60– .65
July, 1918	.75– .80	January, 1920	.60– .65
October, 1918	.80– .85	April, 1920	.60– .65
January, 1919	.60– .65	July, 1920	.60– .65
April, 1919	.60– .65	October, 1920	.60– .65

Epsom salts, prices (wholesale), New York.

[From Oil, Paint, and Drug Reporter.]

In bags:		In barrels:	
August, 1914 [1]	$1.00 –$1.10	August, 1914 [1]	$1.00 –$1.10
January, 1915	.01½– .02	January, 1915	.01½– .02
April, 1915	.01½– .01½	April, 1915	.01½– .01½
July, 1915	.03½– .04	July, 1915	.03½– .04
October, 1915	.04½– .06	October, 1915	.04½– .06
January, 1916	.03½– .04½	January, 1916	.03½– .04½
April, 1916	.03½– .04	April, 1916	.03¼– .04
July, 1916	.02½– .03	July, 1916	.03 – .03½
October, 1916	.01½– .02	October, 1916	.01½– .02
January, 1917 [1]	1.75 – 1.85	January, 1917 [1]	1.75 – 1.85
April, 1917 [1]	3.75 –	April, 1917 [1]	4.00 – 4.25
July, 1917 [1]	4.25 –	July, 1917 [1]	4.00 – 4.25
October, 1917 [1]	4.10 – 4.25	October, 1917 [1]	3.90 – 4.10
January, 1918 [1]	3.37½– 3.50	January, 1918 [1 2]	3.62½– 3.90
April, 1918 [1]	3.37½– 3.50	April, 1918 [1 2]	3.62½– 3.90
July, 1918 [1]	3.37½– 3.50	July, 1918 [1 2]	3.62½– 3.90
October, 1918 [1]	3.37½– 3.50	October, 1918 [1 2]	3.62½– 3.90
January, 1919 [1]	3.37½– 3.50	January, 1919 [1]	3.62½– 3.90
April, 1919 [1]	2.25 – 2.35	April, 1919 [1]	2.50 – 2.60
July 1919 [1]	1.80 – 2.00	July, 1919 [1]	2.25 – 2.35
October, 1919 [1]	1.87½– 1.90	October, 1919 [1]	2.50 – 2.75
January, 1920 [1]	1.87½– 1.90	January, 1920 [1]	2.50 – 2.75
April, 1920 [1]	3.00 – 3.25	April, 1920 [1]	3.40 – 3.50
July 1920 [1]	3.00 – 3.25	July, 1920 [1]	5.50 – 6.00
October, 1920 [1]	3.00 – 3.25	October, 1920 [1]	3.50 – 3.75

[1] Technical—per 100 pounds.

[2] United States Pharmacopœia.

Carbonate of magnesia, prices, wholesale, New York, per pound, in barrels.

[From Oil, Paint, and Drug Reporter.]

	Cents.
Aug., 1914	5½-6
Jan., 1915	4½-5½
Apr., 1915	4½-5½
July, 1915	4½-5½
Oct., 1915	4½-5½
Jan., 1916	14-15
Apr., 1916	16-17
July, 1916	19-22
Oct., 1916	19-22
Jan., 1917	20-23
Apr., 1917	22-22
July, 1917	20-20
Oct., 1917[1]	18-22
Jan., 1918[1]	18-22
Apr., 1918[1]	20-21
July, 1918[2]	20-21
Oct., 1918[2]	25-30
Jan., 1919	25-30
Apr., 1919	25-30
July, 1919	21-22
Oct., 1919	21-22
Jan., 1920	21-22
Apr., 1920	17-21
July, 1920	17-21
Oct., 1920	18-19
Technical, in barrels:	
Jan., 1917	10½-12½
Jan., 1918	10-10½
Apr., 1918	15-16
July, 1918	15-16 / [3] 12-13
Oct., 1918	[3] 16-17 / 18-20
Jan., 1919	16-18
Apr., 1919	16-18
July, 1919	12½-13
Oct., 1919	12½-13
Jan., 1920	12½-13
Apr., 1920	12-16
July, 1920	12-16
Oct., 1920	12½-13

[1] U. S. P. kegs. [2] U. S. P. barrels. [3] In bags.

Magnesium compound—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	60	Magnesia, medicinal, carbonate of, per pound	5 cents.
1883	61	Magnesia, calcined, per pound	10 cents.
1883	62	Magnesia, sulphate of, or Epsom salts, per pound	One-half cent.
1883	620	Magnesite, or native mineral carbonate of magnesia	Free.
1890	34	Magnesia, carbonate of, medicinal, per pound	4 cents.
		Calcined, per pound	8 cents.
		Sulphate of, or Epsom salts, per pound	Three-tenths cent
1890	640	Magnesite, or native mineral carbonate of magnesia	Free.
1894	24	Magnesia, carbonate of, medicinal, per pound	3 cents.
		Calcined, per pound	7 cents.
		Sulphate of, or Epsom salts, per pound	One-fifth cent.
1894	542	Magnesia, sulphate of, or Epsom salts	Free.
1894	543	Magnesite, or native mineral carbonate of magnesia	Do.
1897	31	Magnesia, carbonate of, medicinal, per pound	3 cents.
		Calcined, medicinal, per pound	7 cents.
		Sulphate of, or Epsom salts, per pound	One-fifth cent.
1897	605	Magnesite, crude or calcined, not purified	Free.
1909	31	Magnesia and carbonate of, medicinal, per pound	3 cents.
		Calcined, medicinal, per pound	7 cents.
		Sulphate of, or Epsom salts, per pound	One-fifth cent.
1909	618	Magnesite, crude or calcined, not purified	Free.
1913	42	Magnesia: Calcined, per pound	3½ cents.
		Carbonate of, precipitated, per pound	1½ cents.
		Sulphate of, or Epsom salts, per pound	One-tenth cent
1913	539	Magnesite, crude or calcined, not purified	Free.

Court and Treasury Decisions.

Henry's calcined magnesia, classified as a medicinal proprietary preparation under the act of 1890, was held dutiable as calcined magnesia under paragraph 34. The fact that the article was labeled with the maker's name was declared not to change its character.—G. A. 2030 (T. D. 13877). *Calcined magnesia*, likewise labeled, had been held dutiable as a medicinal preparation and not as calcined magnesia under the Revised Statutes.—Schedule M, section 2504; Ferguson *v.* Arthur, 117 U. S., 482.

Calcined magnesia of the purity required by the United States Pharmacopœia, 96 per cent of magnesium oxide, and packed in pack-

ages of less than 2½ pounds gross weight, was held to come within paragraph 17 of the act of 1913, fixing a minimum duty on chemical and medicinal compounds so packed.—Abstract 41784.

Calcined magnesite, ground but not purified, was held exempt from duty under paragraph 605 of the act of 1897. Specific enumeration precluded classification by use as a cement.—G. A. 5003 (T. D. 23316). Being a cement excluded the article from the provision in paragraph 543 of the act of 1894 for "magnesite or native mineral carbonate of magnesia."—G. A. 3370 (T. D. 16851). A like decision was made under the act of 1883 where the competing provisions were cement and crude minerals advanced in value.—Appeal, T. D. 9375.

Magnesium carbonate light, classified under paragraph 31 of the act of 1897 as carbonate of magnesium, calcined and medicinal, was found to be "carbonate of magnesium technically but not medicinally," and dutiable under paragraph 3 as a chemical compound.—Abstract 15472 (T. D. 28181).

Sulphate of magnesia, or Epsom salts, which in the act of 1894 appeared both in the dutiable (par. 24) and the free list (par. 542), was held to come within the latter as the later expression of legislative intent, and, furthermore, because doubt arising from the ambiguity had to be resolved in favor of the importer.—United States *v.* Merck, 91 Fed., 639, affirmed by the Circuit Court of Appeals without opinion, T. D. 21902 and 23158; G. A. 3285 (T. D. 16640); and followed in G. A. 4526 (T. D. 21503).

A mechanical mixture of sodium sulphate, sulphate of magnesia, sodium chloride, and mud, was held exempt from duty as a mineral salt obtained by evaporation from mineral waters under paragraph 548 of the act of 1913, and not dutiable under paragraph 42 as sulphate of magnesia. Two of the three members of the Board of General Appraisers declared that in the face of the general congressional intent to admit free of duty all mineral salts obtained in the way set forth in paragraph 548, they could not consider whether or not any particular mineral salt so obtained is more specifically provided for in some other paragraph of the act.—G. A. 8042 (T. D. 37076).

MENTHOL.

SUMMARY.

Menthol is an important medicinal obtained from peppermint oil. It is used chiefly in solution or as a salve (when mixed with petrolatum or other greases), in cough drops, and in various throat and nasal sprays. The United States is one of the largest producers of peppermint oil, but in normal times little if any domestic oil is used for menthol manufacture, since it is in considerable demand for flavoring purposes. Japanese peppermint oil, on the other hand, has a bitter taste and is generally considered inferior for all purposes other than menthol manufacture. For this reason practically all of the menthol consumed in the United States is imported from Japan, and it is only at times of extremely low oil prices that menthol is separated from domestic oil of peppermint. Exports of menthol from Japan for the period 1913–1919 averaged 362,519 pounds per year. Most of the exports go to the United States and the United Kingdom.

Imports of menthol prior to 1913 averaged about 40,000 pounds, valued at approximately $100,000. The duty of 25 per cent ad valorem (under one of the general provisions) yielded an average annual revenue of about $40,000. In the act of 1913 menthol was taken from the general provision and a specific duty of 50 cents per pound was provided. This duty in 1914 was equivalent to 16.6 per cent ad valorem, and following this reduction in duty there was a considerable increase in imports. For the period 1914–1919 imports averaged 162,184 pounds, valued at $474,433, and yielded an average annual revenue of $82,650.

Menthol is a very speculative commodity and an exception among pharmaceuticals in that prices dropped during the war period and then increased rapidly at a time when most drugs were falling. The demand for menthol preparations during the influenza epidemic seriously affected the market in 1918 and 1919, but during the first half of 1920 conditions were gradually returning to the normal.

GENERAL INFORMATION.

Tariff act of 1913.—Paragraph 43, "Menthol, 50 cents per pound."

DESCRIPTION AND USES.

Menthol is a white crystalline substance obtained from oil of peppermint and from other mint oils. The pure product is described by the Pharmacopœia as "colorless crystals having the strong odor and taste of peppermint." Chemically, menthol is a secondary alcohol ($C_{10}H_{19}OH$) and is the chief member of the so-called menthol series of camphor. Other members of this series are discussed in tariff information surveys for camphor and thymol.

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Menthol is used almost exclusively in medicine. It is an antiseptic and local anesthetic, valuable in neuralgia and irritations of the skin. Large quantities are also used in cough drops, sprays, and inhaling tubes. In other forms it is used for the treatment of throat affections. As an external application it is used in alcoholic solution or as a salve (when mixed with petrolatum or other greases).

Official preparations of menthol are menthol inunction, compound menthol inunction, antiseptic solution with pepsin, camphorated menthol, aromatic oil spray, menthol spray, compound menthol spray, menthol petroxylin, and antiseptic powder.

The high price of menthol has led to many attempts at more or less fraudulent substitution. Preparations marketed as menthol, menthol substitutes, or with names suggestive of menthol have frequently consisted of acetanilid containing only enough menthol to impart the characteristic odor. Other preparations of this sort have been found to contain large amounts of spermaceti.

PRODUCTION AND TRADE.

Most of the menthol used in the United States is imported from Japan, notwithstanding the fact that the United States produces approximately one-half the world supply of peppermint. Japanese peppermint oil has a sharp, bitter taste, which renders it inferior for flavoring purposes. It usually contains, however, a larger proportion of free menthol than does the American and European oils, and it is therefore the chief source of the world supply of this important medicinal.

Menthol is occasionally manufactured from American peppermint oil, usually at times when prices for the domestic oil are comparatively low. In general, the demands for flavoring purposes absorb the American crop at a higher price than Japanese peppermint oil can command.

Production statistics for the domestic industry are not available, but it is believed that over 90 per cent of the domestic consumption is of imported menthol.

Japanese production.—The Japanese varieties of peppermint are distinct from those cultivated in Europe and America. Four varieties are cultivated in Japan, one of which—the Akamaru—predominates. This variety is declared to be superior in oil yield but inferior in vigor of growth. Two crops of herbs are harvested in July and October, and in the southern part of Japan three crops may be obtained. The herb is dried carefully and distilled by the farmers and also by buyers. The small still used by farmers is a simple affair; in 1908 a favorite type cost $7.50.

Menthol is separated from the crude distillate by refrigeration. By the majority of small operators this is done by exposure to the natural winter cold; the menthol crystallizes, rises to the top, and is skimmed off. Large operators utilize a simple process of artificial refrigeration by means of ice and salt. Before shipment the menthol is usually purified by recrystallization. Peppermint oil usually contains about 50 to 60 per cent of free menthol, but only 40 to 50 per cent is commercially recovered.

The annual Japanese production of menthol for the period 1908–1918 is shown in the table on page 56; maximum production, amounting to almost 500,000 pounds, occurred in 1915. In 1918, the Japanese peppermint industry was represented by 3,948 plantations and factories employing 7,328 people, of whom 4,636 were men and 2,702 were women. Over one-half of the crude peppermint is raised in Hokkaido (in northern Japan) and the remainder in Hiroshima and Okayama. Menthol and peppermint oil are produced by three factories in Yokohoma and two in Kobe. These products were formerly handled by three long-established Japanese firms. In 1912 an English firm entered the market and caused considerable disturbance by competitive bidding. As a result of this and other disturbing and speculative features, attempts have been made several times to induce the Japanese Government to place peppermint under a monopoly system analogous to the camphor monopoly.[1] Statistics on menthol exports from Japan date from 1886, and exports have fluctuated considerably, but in general a marked increase has been noted in recent years. In 1916, 515,148 pounds were exported—35 per cent to the United States, 36 per cent to the United Kingdom, 18 per cent to France, and the balance to British India.

IMPORTS.

From 1910 to 1913 imports averaged 43,801 pounds per year and yielded an average revenue of $40,987. The act of 1913, which reduced the duty on menthol, was followed by a considerable increase in the imports. For the period 1914–1918 imports averaged 145,873 pounds, and the average annual revenue for the same period was $74,804. Maximum imports in recent years were received during the fiscal year 1919, when 243,743 pounds, valued at $1,055,720, were reported. The value per unit of quantity has varied from $1.54 per pound in 1909 to $5.79 per pound in 1913.

PRICES.

Menthol is an interesting exception in the pharmaceutical class, in that it showed an appreciable drop in price during the war period, followed by a rapid increase during the time when most drugs were falling. From a maximum of $11–$12 in December, 1912, the price of menthol dropped to $2.70–$2.90 in December, 1913. (See tables on p. 58.) The continued fall during 1914 and 1915 was due in part to the unusually large crops of peppermint in Japan and to the reduction in the tariff. The elimination of Germany and Austria from the market also contributed to the oversupply.

During the latter part of 1918 the increased demand on account of the influenza epidemic caused a rise in price which continued during 1919. From $3.15–$3.25 in January, 1918, the price of menthol rose to $12.50–$12.75 in January, 1920. In part this rise was due to frenzied buying by pharmaceutical manufacturers who turned out large quantities of their preparations in anticipation of a return of the influenza epidemic. Many merchants who had purchased menthol at about $3.50 to $5 per pound during the first half of 1918

[1] See Tariff Information Survey on Camphor, par. 36, act of 1913.

resold large quantities during 1919 at a considerable profit. A break in the market had been confidently expected and it is believed that during 1920 the commodity will return to a normal price of about $5 per pound. (Quotation for July 5, 1920, was $6–$6.50 per pound.)

TARIFF HISTORY.

Menthol was not mentioned specifically in the tariff prior to the act of 1913, which, in paragraph 43, provided a specific duty of 50 cents per pound. Prior to 1913 imports of menthol were held dutiable at 25 per cent ad valorem under one of the general clauses. The specific duty in the act of 1913 was equivalent, in 1916, to 24.15 per cent ad valorem. With the increase in price of menthol the ad valorem equivalent has decreased until, in 1919, it amounted to 11.50 per cent.

TARIFF CONSIDERATIONS AND COMPETITIVE CONDITIONS.

American supplies of this important medicinal are imported almost entirely from Japan, notwithstanding the fact that the United States is one of the most important producers of the raw material—crude peppermint oil. American peppermint oil, however, is superior to the Japanese product for flavoring purposes, and this use ordinarily consumes the entire domestic supply. Only at times of very low oil prices has it been profitable to separate the menthol from the domestic oil, even with the tariff differential of 50 cents per pound in favor of domestic manufacture. Some Japanese peppermint oil is imported for the manufacture of menthol in this country, but in general the separation can be carried on more cheaply in Japan.

The reduction in the rate of duty on menthol in 1913 was one of the contributing factors in the decline in prices which occurred during 1914 and 1915. The change in the tariff was followed by a striking increase in imports and subsequent oversupply. Menthol, however, must be regarded as a very speculative commodity, since its market has always been easily influenced by speculation. Its important use in proprietary preparations used during the influenza epidemic has also seriously affected market conditions.

Menthol, considered as a source of revenue, occupies a fairly important position among drug products. The average annual revenue for the period 1914–1919 was $82,650.

Production of menthol in Japan.[1]

	Quantity.	Value.		Quantity.	Value.
	Pounds.			*Pounds.*	
1908	78,594	$107,457	1914	317,423	$781,049
1909	147,835	261,858	1915	497,318	958,259
1910	149,135	275,540	1916	467,541	1,133,066
1911	164,749	475,686	1917	461,514	1,355,534
1912	200,763	994,462	1918	436,547	1,379,907
1913	257,909	989,543			

[1] Source: Thirty-fifth Statistical Report, Department of Agriculture and Commerce, 1920.

Exports of menthol from Japan—Production in principal foreign countries.

Country.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
British India	18,191	$44,048	11,622	$40,711	10,700	$53,584
United Kingdom	26,279	51,711	33,497	105,990	52,819	248,141
France	21,429	45,210	10,399	36,658	16,381	73,759
United States	34,474	71,128	37,385	118,421	34,223	151,263
All other	55,484	111,033	58,587	177,904	63,392	264,938
Total	155,857	323,130	151,490	479,684	177,515	791,685

Country.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
British India	13,927	$75,688	18,537	$52,868	34,894	$77,696
United Kingdom	84,567	382,022	62,278	137,572	78,975	169,841
France	37,949	178,222	29,765	59,755	55,685	115,070
United States	55,268	238,704	119,298	311,453	230,062	466,265
All other	118,761	556,045	129,054	342,768	34,227	70,074
Total	310,472	1,430,681	358,932	904,416	433,843	898,946

Country.	1916		1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
British India	32,934	$88,963	19,799	$53,272				
United Kingdom	190,816	457,581	83,806	205,646				
France	92,222	210,402	3,628	8,980				
United States	182,925	404,485	198,022	463,327				
All other	16,251	39,062	29,607	62,750				
Total	515,148	1,200,493	334,862	793,975	364,414	$772,153	319,964	$1,273,449

Menthol—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1908	25 per cent	20,183	$33,240	$8,310	$1.65	25
1909	do	23,975	36,963	9,240	1.54	25
1910	do	23,051	43,234	10,808	1.88	25
1911	do	50,533	122,977	30,744	2.43	25
1912	do	51,720	200,532	50,133	3.88	25
1913	do	49,896	289,058	72,264	5.79	25
1913	do	12,245	61,850	15,462	5.05	25
1914	50 cents per pound	115,679	347,104	57,839	3.00	16.66
1915	do	111,020	236,759	55,510	2.13	23.44
1916	do	145,203	300,589	72,602	2.07	24.15
1917	do	172,767	398,191	86,383	2.30	21.69
1918	do	172,450	446,386	86,225	2.58	19.32
1919	do	243,743	1,055,720	121,715	4.35	11.50
Calendar year:						
1918	do	150,879	412,448	75,440	2.73	18.29
1919	do	296,179	1,583,430	148,089	5.34	9.35
1920[1]	do	51,300	476,064	25,650	9.28	5.38

[1] 6 months.

Menthol prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$6.90-$7.00	July, 1916	$2.85-$3.00
Apr. 1, 1912	6.50- 7.00	October, 1916	3.25- 3.40
July 1, 1912	6.75- 7.00	January, 1917	3.20- 3.40
Sept. 30, 1912	8.75- 9.00	April, 1917	3.30- 3.35
Dec. 30, 1912	11.00-12.00	July, 1917	3.15- 3.25
Mar. 29, 1913	8.10- 8.25	Oct. 1, 1917	3.10- 3.15
June 30, 1913	6.40- 6.60	Dec. 31, 1917	3.15- 3.25
Sept. 29, 1913	6.00- 6.10	Jan. 5, 1918	3.15- 3.25
Dec. 29, 1913	2.70- 2.90	Apr. 1, 1918	3.30- 3.50
Mar. 30, 1914	3.20- 3.30	July 1, 1918	3.30- 3.40
June 29, 1914	2.95- 3.05	Oct. 7, 1918	5.75- 6.00
August, 1914	2.95- 3.05	Jan. 6, 1919	7.00- 7.50
Oct. 1, 1914	2.85- 3.00	Apr. 7, 1919	5.90- 6.00
January, 1915	2.50- 2.60	July 7, 1919	7.25- 7.50
April, 1915	2.90- 3.00	Oct. 6, 1919	9.50-10.00
July, 1915	2.60- 2.70	January, 1920	12.50-12.75
October, 1915	2.60- 2.75	April, 1920	13.00-13.50
January, 1916	3.25- 3.30	July, 1920	6.00- 6.50
April, 1916	3.25- 3.50	October, 1920	6.50- 6.75

Menthol—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	43	Menthol	50 cents per pound.

COURT AND TREASURY DECISIONS.

Under the act of 1909 and prior tariff laws, menthol was classified as a medicinal preparation. (*McKesson & Robbins* v. *United States*, 3 Ct. Cust. Appls., 515, of 1913; T. D. 4963, of 1881.)

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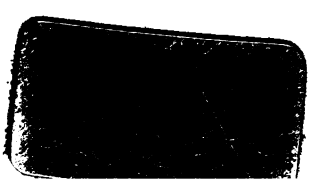

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPH 1 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

Acids in Paragraph 1 and Related Materials

Paragraph 1:
- **Boric Acid**
- **Citric Acid**
- **Formic Acid**
- **Gallic Acid**
- **Lactic Acid**
- **Oxalic Acid**
- **Pyrogallic Acid**
- **Tannic Acid and Tannin**
- **Tartaric Acid**

Paragraph 8:
- **Argols or Wine Lees**
- **Cream of Tartar**
- **Rochelle Salts**
- **Calcium Tartrate, Crude**

Paragraph 30:
- **Extracts of Nutgalls**

Paragraph 41:
- **Citrate of Lime**

Paragraph 67:
- **Sodium Borate or Borax**

Paragraph 429:
- **Crude Borate Materials**

Paragraph 532:
- **Lemon Juice, etc.**

Paragraph 624:
- **Nuts and Nutgalls**

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UNITED STATES TARIFF COMMISSION.

Office: 1322 New York Avenue, Washington, D. C.

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PREFACE.

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In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

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SUMMARY.

Paragraph 1 of the tariff act of 1913 reads as follows:

Acids: Boracic acid, ¾ cent per pound; citric acid, 5 cents per pound; formic acid, 1½ cents per pound; gallic acid, 6 cents per pound; lactic acid, 1½ cents per pound; oxalic acid, 1½ cents per pound; pyrogallic acid, 12 cents per pound; salicylic acid, 2½ cents per pound; tannic acid and tannin, 5 cents per pound; tartaric acid, 3½ cents per pound; all other acids and acid anhydrides not specially provided for in this section, 15 per centum ad valorem.

The following articles covered by other paragraphs of the tariff act have such close industrial relationships with the foregoing acids that they are discussed in connection with the related articles in paragraph 1:

PAR. 8. Argols or crude tartar or wine lees crude or partly refined, containing not more than 90 per centum of potassium bitartrate, 5 per centum ad valorem; containing more than 90 per centum of potassium bitartrate, 5 per centum ad valorem; containing more than 90 per centum of potassium bitartrate, cream of tartar, and Rochelle salts or tartrate of soda and potassa, 2½ cents per pound; calcium tartrate crude, 5 per centum ad valorem.

PAR. 30. Extracts and decoctions of nutgalls * * * not specially provided for in this section; all the foregoing not containing alcohol and not medicinal, three-eighths of 1 cent per pound.

PAR. 41. Lime, citrate of, 1 cent per pound.

PAR. 46. Oils, distilled and essential; orange and lemon, 10 per centum ad valorem. * * *.

PAR. 67. Soda: * * * borate of, or borax refined * * * one-eighth cent per pound.

PAR. 429 (free list). Borax, crude and unmanufactured, and borate of lime, soda, and other borate material, crude and unmanufactured, not otherwise provided for in this section.

PAR. 532 (free list). Lemon juice, lime juice, and sour orange juice, all the foregoing containing not more than 2 per centum of alcohol.

PAR. 624 (free list). Tanning material: * * * nuts and nutgalls and woods used expressly for dyeing or tanning, whether or not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process; and articles in a crude state used in dyeing or tanning; all the foregoing not containing alcohol and not specially provided for in this section.

This report does not include the acids on the free list in the act of 1913 or acids of coal-tar origin.

Paragraph 387 of the free list of the act of 1913 reads as follows:

Acids: Acetic or pyroligneous, arsenic or arsenious, carbolic, chromic, fluoric, hydrofluoric, hydrochloric or muriatic, nitric, phosphoric, phthalic, prussic, silicic, sulphuric or oil of vitriol, and valerianic.

The tariff act of September 8, 1916, covers acids of coal-tar origin. These products are discussed in reports by the Tariff Commission already submitted to Congress entitled "Census of dyes and coal-tar chemicals, 1917," and "Dyes and other coal-tar chemicals," and "Census of dyes and coal-tar chemicals, 1918."

Boracic acid, or boric acid, as it is usually called, is made in the United States from a mineral which occurs abundantly in California. Before the war imports were less than 5 per cent of the American production. Within the last four years a substantial export business has developed.

Citric acid is made from "cull" lemons, and is, therefore, a by-product of the lemon-growing industry. Although this is a large and growing industry in the United States, only a small fraction of the American demand for citric acid is supplied from domestic sources. In Sicily a large proportion of the lemon crop is damaged by insects or other causes and must be marketed in the form of by-products rather than as fresh fruit. The cultural methods of American lemon growers are so much superior to those commonly practiced in Sicily that a much larger proportion of the American crop is salable as fresh fruit. Over 90 per cent of the citric acid consumed in the United States is derived from imported raw material. Imports are, however, mainly in the form of citrate of lime, which is an intermediate stage of the manufacture of the acid from the fruit, rather than in the form of citric acid itself. This is due, at least in part, to the higher tariff on citric acid than on citrate of lime.

Formic acid was controlled by the German industry before the war, not through lack of essential raw materials in other nations, but because German chemists had discovered and developed the best known method of making sodium formate, which serves as the basis for making formic acid. Compressed carbon-monoxide gas is absorbed in hot caustic soda, yielding sodium formate. Formic acid was made in the United States before the war from imported sodium formate. During the war the complete process of making this acid from caustic soda and coke has been developed in the United States. The Germans had an advantage in technical experience and commercial connections which would have made it difficult for any American manufacturer to make a successful start in this industry, if competition from Germany had not ceased. During the war several American firms began the manufacture of this acid.

Tannic acid and *tannin*, *gallic acid*, and *pyrogallic acid* are all made from nutgalls, which are not produced in the United States in commercial quantities. Supplies of nutgalls come chiefly from China and Asia Minor. Imports of tannic acid have never been more than about 6 per cent of the American production. Imports have come almost entirely from Germany. The production of gallic acid increased greatly during the war on account of its use in the manufacture of a blue dye for wool which has been much used in Navy uniforms. Pyrogallic acid is made from gallic acid and is, therefore, dependent on imported nutgalls. Imports of pyrogallic acid have been larger in proportion to the domestic consumption than for either tannic acid or gallic acid.

Lactic acid was first manufactured on a commercial scale in the United States, and its chief uses were developed in the American industries. It is obtained by a fermentation process which can utilize any one of several waste products available in the United States. The technical grade of the acid, used largely by the tanning

industry, is produced in amounts sufficient to satisfy domestic requirements. Recent commercial developments point to an increased production of an edible grade of lactic acid, which will probably prove a serious competitor of citric and tartaric acids.

Oxalic acid is made in the United States by two different processes, but the industry had severe German competition before the war, with imports several times as large as the American production. The process in use by the only American manufacturer before the war depends on heating sawdust with caustic potash, which had to be imported from Germany or made in the United States from German muriate of potash. The Germans had invented and put into successful operation a better process, which is closely allied to the manufacture of formic acid referred to in a previous paragraph. The first step in the manufacture of oxalic acid by this method is to make sodium formate, which is the basis for making both formic and oxalic acids. A promising beginning has been made during the war in the United States in the manufacture of oxalic acid by the new process from locally available raw materials—caustic soda, coke, sulphuric acid, and lime.

Tartaric acid, like citric acid, is manufactured in the United States from imported raw materials, and there is even less prospect of the development of American supplies of the fundamental raw material. Tartaric acid and the closely related cream of tartar are made from wine lees and argols or crude calcium tartrate, which are by-products of the wine industry. The American wine industry supplied about 1 per cent of the world's supply of argols, but even this supply will be cut off when the manufacture of wine in the United States is stopped, as required by the prohibition amendment to the United States Constitution. A small amount will be obtained from the grape-juice industry, but the United States must import either argols and wine lees or refined tartaric acid and cream of tartar. In the past tariff rates have been so adjusted as to encourage the importation of the crude materials, which are refined in the United States.

Salicylic acid is no longer dutiable under paragraph 1 of the act of 1913, but dutiable under the act of September 8, 1916, which imposes a duty of 2½ cents per pound and 15 per cent ad valorem. The latter act deals with chemicals of coal-tar origin and specifically repeals the provision for salicylic acid in paragraph 1 of the act of 1913. Salicylic acid is not discussed in detail in this pamphlet, since it is referred to in earlier reports of the Commission dealing with chemicals of coal-tar origin.

There are many acids which, if imported, would be dutiable under the provision for "all other acids and acid anhydrides not specially provided for in this section, 15 per centum ad valorem." The acids not specially provided for which are actually imported in the largest amounts are oleic acid, stearic acid, and barbituric acid.

Oleic acid is made from vegetable oils, especially cottonseed oil. This acid is used in the textile industry in the dyeing and finishing of fabrics, in the manufacture of soap, and in the manufacture of cosmetics, especially cold creams. Imports during the fiscal year ending June 30, 1914, amounted to 234,756 pounds, valued at $17,347.

This is approximately 1 per cent of the production of the United States.

Stearic acid is made from beef tallow or other fats and is used chiefly in the manufacture of candles. Imports during the year ending June 30, 1914, were 100,000 pounds, which is less than 1 per cent of the American production.

Barbituric acid is a synthetic product which is used in the manufacture of certain drugs. Imports during the fiscal year ending June 30, 1914, amounted to 39,924 pounds, valued at $2,837, and came entirely from Germany.

THE BORIC-ACID AND BORAX INDUSTRY.

The tariff act of 1913 contains the following provisions:

Par. 1. Acids: Boracic acid, three-fourths cent per pound; * * *
Par. 67. Soda: * * * borate of, or borax, refined, * * * one-eighth cent per pound; * * *.
Par. 429 (free list). Borax, crude and unmanufactured, and borate of lime, soda, and other borate material, crude and unmanufactured, not otherwise provided for in this section.

DESCRIPTION AND USES.

The most important derivatives of the chemical element, boron, are boric acid and borax. Boric acid is a white crystalline substance, which is readily soluble in hot water and forms salts with many metals. The term "boracic acid," which appears in the tariff, is practically obsolete and has been replaced by the name, boric acid, both in commercial and scientific usage. Ordinary borax, which is sodium tetraborate, is the most important derivative of boric acid. It is a white powder similar in appearance to boric acid, is readily soluble in water, and gives a faintly alkaline solution.

The largest use for borax is in making the enameled coating for cast-iron and steel ware which is largely used in plumbing fixtures, equipment for chemical factories, and kitchen utensils. It is one of the most essential constituents of these enamels, and is also used in certain glazes for china and earthenware.

Considerable borax is used in the glass industry, for in glass making the boron compounds impart a high refractiveness, reduce the tendency to devitrification, and lower the melting point and the coefficient of expansion. By reducing the coefficient of expansion, borax gives a variety of glass which is but slightly susceptible to changes in temperature. These varieties, known as borosilicate glasses, are used largely in incandescent lamps and lamp chimneys. A new variety of glass containing borax which can be used for baking dishes has recently been developed in the United States. When boric acid is used in connection with other acid oxides, glasses are obtained which are very resistent to chemical action, especially if the proportion of boric anhydride is not greater than 10 per cent. It is this sort of glass that is being used in the manufacture of high-grade beakers, flasks, and other laboratory glassware. The manufacture of these high-grade products in the United States has been greatly developed during the war.

Considerable borax is used in the laundry and kitchen. It is a convenient water softener and by reacting with the soap-destroying constituents of a hard water it effects a saving of soap. Borax soaps find a ready market in localities where the water supplies are excessively mineralized. Borax is a constituent of certain starches, particularly those used to give a high gloss to linen collars. Similar use is found in the paper mills, where borax is used in the various sizes and coatings for book paper and playing cards. The hat makers

Boric acid may be made from the crude borax by the addition of sulphuric acid, followed by crystallization, or directly from the colemanite by the addition of sulphuric acid.

Borax and boric acid are produced in the United States by the following companies:

The Pacific Coast Borax Co., of New York City.
Charles Pfizer & Co., of New York City.
The Stauffer Chemical Co., of San Francisco.
The Thorkildsen-Mather Co., of Chicago.

The output in the United States is shown in the following table. The figures for 1914 are from the Federal Census and the figures for subsequent years from reports received by the Tariff Commission directly from manufacturers.

TABLE II.—*Production of refined borax and boric acid in United States, 1914–1917.*

	Borax.		Boric acid.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
1914	26,561	$2,071,774	4,295	$583,981
1915	26,749	2,208,631	4,270	672,380
1916	27,969	3,358,432	5,812	1,227,005
1917	28,309	3,805,711	5,888	1,383,783

IMPORTS.

Imports of boric acid have been less than 5 per cent of the domestic production. In 1914 Italy furnished 80 per cent of the imports, 18.5 per cent came from England, and the balance from Germany. Imports of refined borax have been entirely negligible, less than 0.01 per cent of the domestic production.

TABLE III.—*Imports of boric acid for consumption in the United States, 1909–1919.*

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	5 cents per pound	236,968	$7,641	$11,548	$0.08	151.14
1910 [1]	do	23,863	903	1,193	.04	132.13
1910 [2]	3 cents per pound	392,979	12,707	11,789	.03	92.78
1911	do	343,694	12,733	10,292	.04	80.84
1912	do	276,496	10,548	8,294	.04	78.76
1913	do	362,400	13,897	10,872	.04	78.23
1914 [1]	do	95,691	3,780	2,869	.04	75.91
1914 [2]	¾ cents per pound	431,550	18,610	3,237	.04	17.39
1915	do	401,684	18,002	3,012	.05	16.73
1916	do	424,219	22,145	3,181	.05	14.37
1917	do	494,710	24,599	3,932	.05	12.33
1918	do	195,450	14,087	1,467	.06	10.42
1919	do	289,935	31,170	2,107	.11	6.76
1919 (calendar year)	do	276,795	20,716	1,985	.08	6.79

[1] Under old tariff act. [2] Under new tariff act.

TABLE IV.—*Imports of refined borax for consumption in United States, 1910–1919.*

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910 [1]	5 cents per pound	939	$114	$46	$0.120	41.18
1910 [2]	2 cents per pound	8,019	1,365	160	.170	11.75
1911	do	7,319	790	146	.108	18.53
1912	do	6,400	604	128	.094	21.22
1913	do	11,768	882	235	.075	26.68
1914 [1]	do	466	63	9	.135	14.66
1914 [2]	½ cent per pound	4,522	641	5	.142	.88
1915	do	2,265	314	2	.139	.89
1916	do	682	112		.165	.77
1917	do	614	109		.177	.71
1918	do	2	1			
1919	do	378	159		.422	.30
1919 (calendar year)	do	378	155	1	.408	.30

[1] Under old tariff act. [2] Under new tariff act.

EXPORTS OF BORAX AND BORIC ACID.

There are no statistics on exports available. It is, however, known that before the beginning of the European War exports were small and chiefly to the Orient, but that during the war a substantial export business to Europe was developed. The scarcity of ocean shipping has forced the European nations to supply their needs with refined products from the United States rather than with crude borate material from Chili and Turkey.

THE BORIC-ACID AND BORAX INDUSTRIES IN FOREIGN COUNTRIES.

Although no statistics of production in foreign countries are available, the import and export statistics show that England and France have large manufacturing industries based on imported raw materials. The German statistics do not show the amount of crude materials imported, but do show that imports of borax and boric acid exceed the export of these commodities. Italy exports boric acid made from Italian raw materials, but imports borax.

IMPORTS AND EXPORTS OF FRANCE.

TABLE V.—*Imports of crude borate materials into France.*

Year.	Borate of lime.		Crude borax.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	4,631,424	$101,364	18,390,099	$430,457
1911	18,966,815	395,389	6,041,950	158,658
1912	19,184,650	419,876	6,282,449	186,997
1913	6,291,708	137,701	29,862,189	888,849
1914	1,102,961	24,139	18,150,031	540,236
1915	5,210,572	114,063	2,404,557	126,306

TABLE VI.—*Imports and exports of refined borax for France.*

Year.	Imports into France.		Exports from France.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	121,033	$4,768	11,251,177	$443,239
1911	167,329	6,006	10,719,206	384,746
1912	220,680	9,273	11,366,918	477,652
1913	195,989	8,236	9,378,368	394,091
1914	122,355	5,142	5,345,273	224,615
1915	65,918	4,039	3,515,676	208,519

TABLE VII.—*Imports and exports of boric acid for France.*

Year.	Imports into France.		Exports from France.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	108,687	$6,423	1,454,375	$85,943
1911	66,799	3,977	4,524,060	269,318
1912	132,496	9,511	4,191,386	267,860
1913	147,488	10,329	4,749,149	299,348
1914	132,056	10,405	4,143,987	290,226
1915	155,865	15,010	2,844,154	271,398

IMPORTS AND EXPORTS OF FRANCE FOR THE YEAR 1913 BY COUNTRIES.

TABLE VIII.—*Imports of crude borax and borate of lime into France, 1913.*

Country of origin.	Crude borax (pounds).	Borate of lime (pounds).
Turkey	13,325,043	1,851,864
Chile	16,526,123	4,439,844
Germany	9,259	.....
All others	1,764	.....
Total	29,862,189	6,291,708

TABLE IX.—*Imports and exports of refined borax for France, 1913.*

Countries.	Imports into France (pounds).	Exports from France (pounds).
Great Britain	52,028	1,577,171
Germany	121,253	462,525
Belgium	15,652	3,802,274
Holland	4,188	3,287,500
Algeria	.....	23,589
Indo-China	.....	47,619
All others	2,867	177,690
Total	195,988	9,378,368

TABLE X.—*Imports and exports of boric acid for France, 1913.*

Countries.	Imports into France (pounds).	Exports from France (pounds).
Great Britain	86,420	2,284,847
Holland	2,866	677,694
Belgium	5,952	1,072,097
Italy	47,840	.....
Germany	4,409	281,086
Spain	.....	190,257
Argentina	.....	77,161
Algeria	.....	27,558
Indo-China	.....	16,094
All other	.....	122,355
Total	147,487	4,749,149

TABLE XI.—*Imports of borate materials into Great Britain, 1910–1918.*

Year.	Boracite.		Borate of lime.		Borax.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1910	7,821,296	$146,068	24,753,008	$443,942	3,311,952	$117,390
1911	9,265,760	169,948	33,274,752	586,374	2,919,728	102,888
1912	9,125,760	175,569	34,007,120	609,875	3,364,816	125,979
1913	10,056,032	193,409	40,566,064	721,152	1,897,280	73,139
1914	12,107,424	231,246	31,531,696	574,096	1,512,224	58,773
1915	.....	.....	43,584,464	881,917	2,825,984	134,705
1916	1,232,000	54,870	38,292,352	1,102,180	2,030,112	124,762
1917	.....	.....	26,090,736	1,271,753	4,198,768	298,112
1918	733,152	33,092	18,538,688	1,031,606	1,846,320	177,647

TABLE XII.—*Imports and exports of boric acid and borax for Germany, 1910–1913.*

Year.	Imports into Germany.		Exports from Germany.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	9,925,991	$359,142	6,992,330	$335,342
1911	12,158,810	440,776	7,063,097	395,794
1912	17,587,197	664,486	7,340,436	384,132
1913	16,271,712	632,366	7,568,833	413,406

The Italian industry is based on their natural resources of crude boric acid. Italian exports of boric acid are, however, less than the exports of either France or Germany, which rely almost entirely on imported raw materials. Italy imports borax.

TABLE XIII.—*Imports and exports of crude boric acid for Italy, 1910–1917.*

Year.	Imports into Italy.		Exports from Italy.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	441	$15	1,968,487	$77,548
1911	.....	.....	1,989,652	73,157
1912	.....	.....	1,871,926	68,828
1913	.....	.....	1,700,849	77,428
1914	220	12	1,475,539	77,505
1915	220	14	809,970	49,636
1916	.....	.....	604,722	74,116
1917	.....	.....	238,538	29,236

TABLE XIV.—*Imports and exports of refined boric acid for Italy, 1910–1917.*

Year.	Imports into Italy.		Exports from Italy.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	192,021	$10,422	1,205,916	$65,454
1911	248,899	12,638	839,732	42,638
1912	162,259	8,239	1,598,996	81,190
1913	46,076	2,824	1,258,827	77,142
1914	6,393	448	1,148,597	80,442
1915	441	37	2,612,671	217,288
1916	3,086	500	2,850,768	464,701
1917	----------	----------	2,205,923	357,264

TABLE XV.—*Imports and exports of borax for Italy, 1910–1917.*

Year.	Imports into Italy.		Exports from Italy.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	609,131	$21,864	211,201	$7,581
1911	1,284,258	48,474	139,772	4,804
1912	675,289	23,646	190,918	6,686
1913	304,896	12,611	66,358	2,614
1914	616,674	26,731	9,709	425
1915	1,583,123	94,243	329,147	19,594
1916	2,167,783	237,221	1,167,556	127,766
1917	1,399,307	152,470	9,259	1,013

PRICES.

The price of borax and boric acid has about doubled since the outbreak of the European war. For several years before the war the normal price of borax was 4 to 4½ cents per pound and of boric acid 7 to 8 cents per pound. At the close of the war borax was selling at about 8 cents per pound and boric acid at about 14 cents per pound.

TARIFF HISTORY.

The tariff act of 1897 contains the following provisions:

Par. 1. Acids: Boracic, 5 cents per pound.

Par. 11. Borax, 5 cents per pound; borates of lime or soda, or other borate material not otherwise provided for, containing more than 36 per cent of anhydrous boracic acid, 4 cents per pound; borates of soda, or other borate material not otherwise provided for, containing not more than 36 per cent of anhydrous boracic acid, 3 cents per pound.

The act of 1909 contains the following provisions:

Par. 1. Acids: Boracic acid, 3 cents per pound.

Par. 11. Borax, 2 cents per pound; borates of lime, soda, or other borate material not otherwise provided for in this section, 2 cents per pound.

The act of 1913 contains the following provisions:

Par. 1. Acids: Boracic acid, ¾-cent per pound.

Par. 67. Soda: Borate of or borax refined, ¼-cent per pound.

Par. 429 (free list). Borax, crude and unmanufactured, and borate of lime, soda, and other borate material, crude and unmanufactured, not otherwise provided for in this section.

TABLE XVI.—*Rates of import duties on borax in principal countries.*

Countries.	Tariff No.	Foreign rate.	United States equivalents (dollars per pound).[1]
United States:			
Crude	429		Free.
Refined	67		½ cent per pound.
United Kingdom		Free	Free.
France:			
Crude [2]	261	Free	Free.
General tariff [3, 4]	261	10 francs per 100 kilos	$0.0067.
Minimum tariff [4]	261	8 francs per 100 kilos	$0.0070.
Germany	275	Free	Free.
Russia:			
Crude [5]	93 (1)	.05 copeks+10 per cent per pood	$0.0007.
Refined [6]	93 (4)	1.80 roubles+10 per cent per pood	$0.0282.
Italy [7]	58	5 lire per quintal	$0.0043.
Canada: [8]			
British preferential		5 per cent ad valorem	5 per cent ad valorem.
Intermediate		7½ per cent ad valorem	7½ per cent ad valorem.
General [9]		7½ per cent ad valorem	7½ per cent ad valorem.
Chile [10]	1552	10 centavos per kilo gross	$0.0166.
Australia [11]	28		
British preferential		Free	Free.
General tariff [9]		5 per cent ad valorem	5 per cent ad valorem.
Japan [12]	170	Free	Free.

[1] Conversions into United States currency are based on par value.
[2] Borax, crude, natural, or artificial.
[3] The general rate applies to the United States.
[4] Borax, refined or half refined.
[5] Borocalcite, boracite, etc., also crude borax, not purified (borax tincal).
[6] Borax, purified, in crystals, powder, or anhydrous.
[7] Borax or borate of soda.
[8] Borax in packages of not less than 25 pounds weight.
[9] The general rate applies to the United States.
[10] Borate (borax), whole; borate (borax,) in powder.
[11] Chemicals and drugs, n. e.i. other than those packed for use in the household.
[12] Soda, borate of (borax).

TABLE XVII.—*Rates of import duties on boric acid in principal countries.*

Countries.	Tariff No.	Foreign rate.	United States equivalents (dollars per pound).[1]
United States	1		¾ cent per pound.
United Kingdom		Free	Free.
France [2]	238	do	Do.
General tariff [3]	238	18 francs per 100 kilos	$0.0157.
Minimum tariff		12 francs per 100 kilos	$0.0105.
Germany	275	Free	Free.
Russia:			
Not purified	93 (2)	30 copeks+10 per cent per pood	$0.0047.
Purified [4]	112 (1)	3.60 roubles+10 per cent per pood	$0.0564.
Italy:			
Crude	37 (d)	Free	Free.
Refined	37 (d)	7 lire per quintal	$0.0061.
Canada: [5]			
British preferential		5 per cent ad valorem	5 per cent ad valorem.
Intermediate		7½ per cent ad valorem	7½ per cent ad valorem.
General tariff [6]		7½ per cent ad valorem	7½ per cent ad valorem.
Chile	1355	12 centavos per kilo gross	$0.0198.
Australia:			
British preferential	280 (b)	7s. per hundredweight	$0.0152.
General tariff		8s. 6d. per hundredweight	$0.0184.
Japan	153	3.20 yen per 100 kin	$0.0120.

[1] Conversions into United States currency are based on par value.
[2] Boric acid, natural from Tuscany, containing 15 per cent or more of impurity.
[3] The general rate is applied to the United States.
[4] In crystals, powder, or anhydrous.
[5] Boracic acid in packages of not less than 25-pound weight.
[6] The general rate is applied to the United States.

COURT AND TREASURY DECISIONS.

(Decisions under the act of 1897.)

Borate material.—The provision in paragraph 11 for "other borate material" includes only borate materials found in nature in a raw condition, such as the "borates of lime or soda" enumerated in the same provision, and does not include borate of manganese, or bormangan, a manufactured article which is made from manganese and borates of lime or soda, which is held to fall within the provision in paragraph 3 for chemical compounds and salts. (Hempstead *v.* Thomas (C. C. A.), 129 Fed., 907, T. D. 25315.

Borax glass.—Borax glass, or fused borax, was claimed to be dutiable as the cruder material, *borate of soda*, but the protest was overruled and the collector's decision affirmed that borax glass is a variety of borax and as such is dutiable at the rate of 5 cents a pound under the provisions of paragraph 11. (T. D. 25149 (G. A. 5621).)

(Decisions under the act of 1909.)

Boracic acid and borax mixture.—An antiseptic preservative consisting of boracic acid and borax, mechanically mixed, boracic acid in chief value, was held dutiable as boracic acid by similitude. (Berth Levi & Co. *v.* United States, 126 Fed. 420, T. D. 25050.)

Perborate of soda.—Under neither the tariff act of 1897 nor the tariff act of 1909 may perborate of soda be classed as a borate material. It is the product of a chemical reaction, is a chemical compound, and dutiable as such under paragraph 3 of each of said acts. (Morgenstern & Co. *v.* United States (2 Ct. Cust. Appls., 212), T. D. 31949; (G. A. Ab. 23840) T. D. 30865, affirmed.)

CITRIC ACID AND OTHER BY-PRODUCTS OF THE LEMON-GROWING INDUSTRY.

The tariff act of 1913 covers the by-products of the lemon-growing industry under the following paragraphs:

Par. 1. * * * Citric acid, 5 cents per pound * * *.

Par. 5. Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures, and salts, and combinations thereof not specially provided for in this section, 15 per centum ad valorem. (This clause covers many salts of citric acid, including the citrates of ammonium, bismuth, caffeine, copper, iron, magnesium, nickel, potassium, and silver, which are used chiefly as drugs.)

Par. 41. Lime, citrate of, 1 cent per pound.

Par. 46. Oils, distilled and essential: * * * lemon, 10 per cent ad valorem * * *.

Par. 532. (Free list.) Lemon juice, lime juice, and sour orange juice, all the foregoing containing not more than 2 per centum of alcohol. (This clause covers not only the natural juice, just as it is obtained by pressing the fruit, but also a more concentrated product from which most of the water has been removed by evaporation.)

Lemons are dutiable under the following paragraph:

Par. 220. Lemons, limes, oranges, grapefruit, shaddocks, and pomelos in packages of a capacity of 1¼ cubic feet or less, 18 cents per package; in packages of capacity exceeding 1¼ cubic feet and not exceeding 2½ cubic feet, 35 cents per package; in packages exceeding 2½ and not exceeding 5 cubic feet, 70 cents per package; in packages exceeding 5 cubic feet or in bulk, one-half of 1 cent per pound.

DESCRIPTION AND USES.

Citric acid, as its name implies, occurs principally in the juice of the citrus fruits and is chiefly responsible for the sour taste of these fruits. Commercially it is derived mainly from the juice of the lemon, although smaller amounts are obtained from the lime, bergamot, and orange. Citric acid is usually made from the inferior fruit or "cull lemons" which have been damaged by insects, fungi, or frost, or which are misshapen, undersized or even oversized. It may be regarded, therefore, as a by-product of the lemon-growing industry.

The principal use of citric acid is in the manufacture of beverages and effervescent salts. It is also used in the manufacture of many salts which are used in medicine, including the citrates of ammonium, bismuth, caffeine, iron, lithium, magnesium, potassium, quinine, and sodium. Citric acid and sodium citrate find some application in textile printing and in the manufacture of a few dyes. Many formulas for photographic developers and toning baths contain citric acid or sodium citrate. Ferric ammonium citrate is used in the manufacture of blue print paper. Citric acid and ammonium citrate are important laboratory reagents. They are essential for the

determination of phosphates in fertilizers, which ranks as one of the most important of analytical operations.

Citrate of lime is an intermediate substance obtained in the manufacture of citric acid from the fruit juices and is used for making citric acid.

As cull lemons, on account of their bulk and perishable nature, can not be shipped for long distances, the commercial practice has been for growers to deliver them to local plants for conversion into citrate of lime, which is easily made from the fruit and which is not subject to decay or deterioration during shipment and storage.

The manufacture of citric acid from citrate of lime is a relatively complex chemical operation, requiring special equipment and careful chemical control. Citrate of lime has, therefore, become an article of commerce, purchased by chemical factories specializing in the manufacture of citric acid and citrates therefrom.

Some growers prefer to ship a juice which has been concentrated by evaporation instead of making the citrate of lime.

Lemon oil, although entirely different from citric acid in chemical nature and uses, is, like citric acid, a by-product of the fruit-growing industry, and is, therefore, conveniently discussed with citric acid. It is used in flavoring extracts, perfumes, and medicine.

PROCESS OF MANUFACTURE IN SICILY.

The chief centers of the lemon-growing industry, and, therefore, the chief sources of the by-products, are Sicily, California, and the West Indies. The industry is older and larger in Sicily than in California or the West Indies.

The proportion of the total crop which is not salable as fresh fruit, and which is, therefore, treated as "culls" for the conversion into by-products, varies greatly with the skill of the grower, the season, and the market conditions. In seasons when the fruit is plentiful and low in price, the grading may be more severe, and a larger proportion rejected as culls. In Sicily the proportion of culls converted into by-products is commonly as high as 30 per cent, and sometimes as high as 50 per cent of the total crop.

The Sicilians cut the fruit in two and remove the pulp from the peel by means of a single knife operated by hand. The lemon oil is then pressed out of the peel into a sponge by the aid of a simple tool operated by hand. The lemon oil obtained in this way is the highest quality hand-pressed oil. The peel is uninjured and may be candied. The pulp is mechanically shredded and the juice separated in a press. The residue in the press may be fed to cattle or goats. The juice is filtered and heated nearly to the boiling point. Finely divided chalk is then added. The citric acid present in the juice combines chemically with the chalk, forming citrate of lime, a white insoluble powder which can be readily filtered, washed, and dried.

Chemically pure citrate of lime contains 73.67 per cent expressed as crystallized citric acid. Commercially the citric acid content of citrate of lime varies from about 60 to 67 per cent. The standard commercial strength is 64 per cent.

The manufacture of citric acid from citrate of lime, although simple in theory, requires careful attention to details, because the

product is used chiefly in drugs and beverages and must therefore be of a high degree of purity. The citrate of lime is treated with dilute sulphuric acid and is filtered from the precipitated calcium sulphate. It is then concentrated by evaporation and recovered by crystallization. The crystals are usually redissolved, the solution decolorized by animal charcoal and chemically treated to remove traces of impurities, especially iron or lead derived from the vessel. The acid is then recovered by evaporation and crystallization.

Until a few years before the outbreak of the European war, almost the entire product was shipped from Sicily in the form of citrate of lime, and the manufacture of citric acid therefrom was carried out in other countries, especially the United States, France, England, and Germany. This is shown by Tables I to III, which give the exports of citrate of lime and citric acid from Italy.

Another significant fact shown by these tables is that beginning about 1913 there was a considerable expansion in the manufacture of citric acid in Italy.

The figures, taken from official Italian sources, are converted into American weights and currency for convenience of comparison with later tables:

TABLE I.—*Exports of citrate of lime and citric acid from Italy, 1909–1917.*[1]

Year.	Citrate of lime.		Citric acid.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1909	5,248,932	$735,222	3,527	$714
1910	13,834,967	1,853,092	1,764	548
1911	17,964,844	2,406,259	35,935	7,156
1912	16,931,089	2,356,854	5,071	1,642
1913	8,405,919	1,221,577	486,114	191,504
1914	12,539,324	2,063,762	1,320,114	635,626
1915	14,779,038	2,458,357	1,665,134	1,093,297
1916	16,047,063	3,441,829	2,302,925	2,016,078
1917	12,869,793	2,760,356	1,834,227	1,605,760

[1] From Movimento Commerciale del regno d'Italia.

TABLE II.—*Exports of citrate of lime and citric acid, from Italy, by countries, 1913.*[1]

Exported to—	Citrate of lime.		Citric acid.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Austria	539,466	$78,397	1,102	$434
France	2,103,629	305,707	29,321	11,551
Germany	1,070,554	155,577	75,177	29,616
Great Britain	1,946,221	282,831	53,572	21,105
Netherlands	184,966	26,880	160,274	63,140
United States	2,561,083	372,185	8,813	3,474
All other			157,849	62,184
Total	8,405,919	1,221,577	486,114	191,504

[1] From Movimento Commerciale del regno d'Italia.

TABLE III.—*Exports of citrate of lime and citric acid from Italy, by countries, 1917.*[1]

Exported to—	Citrate of lime.		Citric acid.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
France	1,149,258		454,809	
Great Britain	4,209,463		691,803	
United States	7,511,072		303,573	
Servia			10,362	
Switzerland			6,614	
All other			367,066	
Total	12,869,793	$2,760,356	1,834,227	$1,605,760

[1] From Statistica del Commercio Speciale di Importazione e di Esportazione

TABLE IV.—*Exports of essential oil of lemon from Italy, 1909–1917.*[1]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1909	803,901	$633,392	1914	1,329,369	$2,094,815
1910	937,123	738,357	1915	1,640,247	1,794,926
1911	1,155,164	1,112,407	1916	1,445,164	1,581,447
1912	1,141,092	1,498,440	1917	1,151,873	957,978
1913	1,005,966	1,320,997			

[1] From Movimento Commerciale del regno d'Italia.

CONTROL OF THE SICILIAN INDUSTRY.

An important feature of the industry is the Sicilian method of selling the citrus products. The Italian Government created a citrus chamber or *Camera Agrumaria* to control and regulate the market for citrus products. This chamber is made up of a certain number of producers and exporters from each of the Provinces together with representatives from the ministries of commerce and agriculture and a president nominated by the council of ministers.

Citrate of lime and citric acid are handled almost exclusively by the Camera which fixes the prices periodically and through its agents allots monthly deliveries to buyers all over the world. It guarantees the producer a certain minimum price for his product and the Italian Government levies an export duty amounting to 1 lire per quintal (0.087 cent per pound) on all sales not made through the Camera Agrumaria. The producers deposit their output with the Camera and they are advanced 80 per cent of the value of the citrate of lime, and the balance is adjusted when the sale is made.

Prices of citrate of lime.—The price of citrate of lime, which in 1914 was 187.5 lire per quintal (16.5 cents per pound), was fixed at 433 lire (37.9 cents per pound) for the fiscal year 1917–18. However, these prices were subject to change by ministerial decree and in October, 1918, the price was increased to 520 lire (45 cents per pound). This price has again been increased until at the present time (December 15, 1919) 700 lire per quintal (61.5 cents per pound) is demanded.

Effect of the war.—The general effect of the war on the Sicilian industry was a decreased exportation of the fruit and a greater conversion to citrate of lime. This has been caused by the scarcity of labor and accordingly the inability properly to cultivate the crop and by the unsettled shipping conditions. The cost of manufacture has increased greatly, and the workmen who were being paid 3 lire for a nine-hour day in 1914 are now receiving 10 lire and up for an eight-hour day.

THE INDUSTRY IN THE UNITED STATES.

The industry in the United States is divided into two distinct branches. Three firms, located along the Atlantic seaboard, specialize in the manufacture of citric acid and citrates from citrate of lime, imported chiefly from Sicily, or made from concentrated juices of citrus fruits, imported chiefly from the Dominican Republic. These firms are the Citro Chemical Co., of Maywood, N. J.; Charles Pfizer & Co., of New York; and Powers, Weightman & Rosengarten, of Philadelphia.

In California there are four firms which make by-products from lemons, namely, W. J. Bush Citrus Products Co., of National City; Exchange By-Products Co., of Corona; North Ontario Packing Co., of Los Angeles; and the United Chemical Co., of Corona.

Some of the Californian firms ship citrate of lime to the eastern manufacturers, while others make citric acid. The W. J. Bush Citrus Products Co. has been in operation for about 15 years; the others have all begun operation since 1915.

The manufacture of citric acid in the United States is shown in the following table. The figures for 1904, 1909 and 1914 are taken from the United States census. The figures for 1915, 1916 and 1917 are compiled from reports made to the United States Tariff Commission by the manufacturers:

TABLE V.—*Citric acid manufactured in the United States, 1904–1917.*

Year.	Quantity.	Year.	Quantity.
	Pounds.		*Pounds.*
1904	2,265,631	1915	3,417,795
1909	2,102,256	1916	4,183,538
1914	2,729,943	1917	4,032,897

A comparison of the situation in Sicily and California shows several interesting differences. In California the cultural methods in the lemon groves are superior to those generally used in Sicily, and the proportion of culls is therefore much less than in Sicily. Although the proportion of culls is variable, it may be roughly estimated at 10 per cent in California, against 30 to 50 per cent in Sicily. The Sicilian method of separating the peel and pressing out the oil by hand is not used in California because of the higher American wages. In California the whole fruit pulp is put through a machine which thoroughly shreds it, and the pulp then passes to a filter press, which yields an emulsion of juice and oil. This emulsion

then passes through a centrifugal separator which separates the oil from the juice. As the separation of oil and juice by this method is not perfect, the oil-fraction must be distilled to secure the lemon oil. The oil obtained in this way is not chemically identical with the hand-pressed oil and brings a lower price, since it is inferior in flavor.

The pulp secured in American practice is not suitable for cattle food, as it contains the rind which the cattle refuse to eat. After the separation of the oil from the juice, the manufacture of citrate of lime and citric acid then proceeds as already described.

The California by-product industry is, however, still small compared with the American consumption. During 1917 about 6,000 tons of lemons were consumed in California in the manufacture of by-products. This is probably about one-half of the total culls available. The output of citric acid was only about 5 per cent of the American consumption.

FUTURE OF THE DOMESTIC BY-PRODUCT INDUSTRY.

There is an opportunity for the growth of the by-product industry in California through the more complete utilization of the culls and through the growth of the lemon-growing industry. The acreage of young, nonbearing lemon groves in California is about 75 per cent of the acreage of bearing trees, and much of the latter is in young orchards which have not reached the full-bearing stage. It may, therefore, be predicted that within five or six years the total crop of lemons will be nearly double that produced during 1918. If the same proportion of the crop were treated as culls, and if all the culls were converted into by-products, the production of by-products would be about four times as great as at present (1918). Should it prove difficult to sell the double crop of lemons at profitable figures, the tendency will be to grade more strictly, and thereby to increase the proportion of culls. It is hardly to be expected, however, that the output of by-products will increase sufficiently to supply the entire American demand.

IMPORTS.

The tables of imports also show that the amount of citric acid, imported as such, is small in comparison with the imports in the form of citrate of lime. Since the imports of citric acid during the years 1910–1912 exceeded the exports from Italy, it is obvious that this acid must have come from European countries other than Sicily. Under the tariff act of 1909, with citrate of lime on the free list and citric acid dutiable at 7 cents per pound, the imports of citric acid dwindled to an insignificant amount. The tariff act of 1913 put a duty of 1 cent per pound on citrate of lime, and lowered the duty on citric acid from 7 cents per pound to 5 cents per pound. These changes in duties, which occurred almost simultaneously with the development of the manufacture of citric acid in Italy (see Table I) were followed by a large increase in imports of citric acid from 8,677 pounds in 1913 to 652,210 pounds during the 1914 fiscal year and to 722,434 pounds during the 1915 fiscal year.

IMPORTS INTO THE UNITED STATES.

TABLE VI.—*Citrate of lime imported for consumption, 1910–1919.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	Free	4,114,256	$568,175		$0.138	
1911	do	5,219,544	712,004		.136	
1912	do	5,903,501	791,416		.134	
1913	do	5,526,954	756,309		.137	
1914 [1]	do	582,770	85,950		.153	
1914 [2]	1 cent per pound	2,557,154	410,567	$25,571	.161	6.23
1915	do	6,242,244	1,109,629	62,422	.177	5.63
1916	do	8,127,364	1,763,652	81,273	.217	4.61
1917	do	6,361,458	1,554,577	63,614	.244	4.10
1918	do	4,013,606	814,073	40,136	.202	4.94
1919	do	2,773,095	1,136,057	27,731	.409	2.44
1919 (calendar year)	do	3,864,330	1,583,761	38,643	.409	2.44

[1] Old law, July 1 to Oct. 3, 1913. [2] New law, Oct. 4, 1913, to June 30, 1914.

TABLE VII.—*General imports of citrate of lime by countries, 1910–1918.*

Country.	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Italy	3,354,404	$464,596	4,499,927	$622,510	4,764,601	$636,430
British West Indies	393,145	53,880	662,790	83,837	570,016	70,151
Mexico	76,182	8,806	55,923	5,473	103,325	7,463
All others	1,283	161	1,904	184	245,310	35,350
Total	3,825,014	527,443	5,220,544	712,004	5,683,252	749,394

Country.	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Italy	5,100,658	$710,287	2,607,660	$390,704	6,194,743	$1,075,015
British West Indies	280,342	35,856	481,514	101,725	267,373	72,993
Mexico	55,261	5,175	6,995	1,155	.....	.....
All others	.....	.....	1,096	154	2,209	570
Total	5,446,261	751,318	3,097,265	493,738	6,464,325	1,148,578

Country.	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Italy	8,672,887	$1,921,688	4,926,633	$1,223,836	4,056,155	$845,450
British West Indies	166,838	30,457	210,013	36,946	46,831	8,183
Mexico	16,954	3,360	10,856	2,105	42,307	4,344
All others	2,499	406	135	27	108,393	21,222
Total	8,859,178	1,955,911	5,147,637	1,262,914	4,253,686	879,199

TABLE VIII.—*Citric acid imported for consumption, 1910–1919.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	7 cents per pound	142,001	$40,967	$9,940	$0.288	24.26
1911	do	97,847	28,717	6,849	.293	23.85
1912	do	67,332	20,275	4,713	.301	23.25
1913	do	8,677	2,916	607	.336	20.83
1914[1]	do	471	192	33	.407	17.17
1914[2]	5 cents per pound	651,739	304,155	32,586	.466	10.71
1915	do	722,434	447,131	36,121	.619	8.08
1916	do	171,877	107,603	8,593	.626	7.99
1917	do	157,528	91,463	7,876	.581	8.61
1918	do	196,590	126,066	9,829	.642	7.80
1919	do	680,146	632,634	34,007	.93	5.38
1919 (calendar year)	do	1,224,591	1,187,267	61,229	.97	5.16

[1] Old law, July 1 to Oct. 3, 1913. [2] New law, Oct. 4, 1913, to June 30, 1914.

TABLE IX.—*Oil of lemons imported for consumption, 1909–1919.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	405,695	$358,197		$0.883	
1910	do	415,819	310,543		.747	
1911	do	430,768	323,552		.751	
1912	do	400,424	491,690		1.23	
1913	do	410,003	794,215		1.94	
1914[1]	do	62,835	187,085		3.00	
1914[2]	10 per cent	263,485	557,699	$55,770	2.12	10.00
1915	do	557,347	621,592	62,159	1.12	10.00
1916	do	435,030	360,862	36,086	.83	10.00
1917	do	557,288	459,179	45,917	.82	10.00
1918	do	577,600	404,568	40,457	.71	10.00
1919	do	345,799	327,370	32,737	.93	10.00
1919 (calendar year)	do	503,758	494,223	49,422	.98	10.00

[1] Old law, July 1 to Oct. 3, 1913. [2] New law, Oct. 4, 1913, to June 30, 1914.

During the fiscal year ending June 30, 1914, imports of citric acid were derived from the following sources: Germany 57 per cent, England 27.7 per cent, Italy 12.8 per cent, Netherlands 1.7 per cent, Belgium 0.7 per cent, and Austria-Hungary 0.1 per cent.

A NEW SOURCE OF CITRIC ACID AND POSSIBLE SUBSTITUTES.

Citric acid is formed by the fermentation of sugar under the proper conditions. Considerable work, which holds much promise of success, has been done on the development of a fermentation process for making citric acid from sugar. Although success on a commercial scale has not yet been attained there is a prospect that this process will in the near future cause a marked change in the competitive situation.

In the past the chief rival commodity or possible substitute has been tartaric acid. As tartaric acid is a by-product of the wine industry, and as the production of wine will probably decline, it seems probable that the competition of tartaric acid will in the future become less severe.

The most serious competitor is likely to be edible lactic acid, which will probably be produced in large amounts at a price substantially

below the prices which have prevailed in the past. (See discussion under lactic acid.)

PRICES.

TABLE X.—*Wholesale prices of citric acid (crystals) at New York, 1911–1919.*[1]

[Cents per pound, spot.]

Month.	1911	1912	1913
January	38½–39	38½–39	38½–39
April	38½–39	38½–39	40 –41
July	38½–39	38½–39	44 –44½
October	38½–39	38½–39	55 –55½
Month.	**1914**	**1915**	**1916**
January	51–51½	55–55½	59–59½
April	51–51½	55–55½	64–64½
July	53–53½	55–55½	55–55½
October	90–95	55–55½	55–55½
Month.	**1917**	**1918**	**1919**
January	65–65½	72–72½	125–125½
April	72–72½	82—	125–125½
July	72–72½	82–88	98—
October	72–72½	82–82½	93–94

[1] From Oil, Paint and Drug Reporter.

TABLE XI.—*Comparison of wholesale prices of citric acid in Italy, Australia, and the United States, by quarters, 1913–1918.*[1]

Years and quarters.	Actual price.			Relative price.		
	Italy.	Australia.	United States.	Italy.	Australia.	United States.
Market	Genoa.	Melbourne.	New York.			
Unit	100 kg.	Pound.	Pound.			
	Lire.	£ *s.* *d.*	*Dollars.*			
Base price[2]	572.25	0 2 3.50	0.5070	100	100	100
1913 First	425.00	0 1 7.08	.3980	74	69	79
Second	464.17	0 1 9.00	.4080	81	76	80
Third	476.25	0 1 10.67	.4500	86	82	89
Fourth	605.00	0 2 3.25	.5330	103	99	105
1914 First	598.33	0 2 5.08	.5100	105	106	101
Second	588.33	0 2 7.00	.5350	103	113	106
Third	680.00	0 2 11.50	.5850	119	129	115
Fourth	715.00	0 3 10.50	.7430	125	169	147
1915 First	681.67	0 3 8.50	.5690	119	162	112
Second	778.33	0 3 4.50	.5890	136	147	116
Third	1,034.17	0 3 3.00	.6225	181	142	123
Fourth	800.00	0 3 4.50	.6080	140	147	120
1916 First	916.67	0 3 3.75	.6730	160	145	133
Second	1,086.67	0 3 5.25	.6925	190	150	137
Third	1,065.83	0 3 6.50	.7175	186	155	142
Fourth	941.67	0 3 4.50	.7125	165	147	141
1917 First	[3]	0 3 4.50	.6980	[3]	147	138
Second	[3]	0 3 7.33	.7500	[3]	158	148
Third	[3]	0 3 11.00	.7650	[3]	171	151
Fourth	[3]	0 4 1.00	.7650	[3]	178	151
1918 First	1,383.33	0 4 2.00	.7940	242	182	157
Second	1,400.00	0 4 2.50	.8475	245	184	167
Third	1,385.00	0 4 6.75	.8525	242	199	168
Fourth	.....	0 4 5.25	1.0470	.....	194	207

[1] Source: International Price Comparisons, Department of Commerce, Washington, 1919.
[2] Average actual prices from July, 1913, to June, 1914.
[3] Statistics not available.

TARIFF HISTORY.

The rates of duty under the successive tariff acts beginning with the act of 1883 on these articles are shown below:

Year.	Citrate of lime.	Citric acid.	Lemon oil.	Lemon juice, lime juice, and sour orange juice.
1883	Free.	10 cents per pound.	25 per cent.	Free (lemon juice, lime juice).
1890	do.	do.	Free.	Free.
1894	do.	25 per cent.	do.	Do.
1897	do.	7 cents per pound.	do.	Do.
1909	do.	do.	do.	Free (not more than 2 per cent alcohol).
1913	1 cent per pound.	5 cents per pound.	10 per cent.	Do.

FOREIGN TARIFFS.

The rates of duty on citrate of lime and citric acid in the principal countries are shown in the following tables:

TABLE XII.—*Rates of import duties on citrate of lime in principal countries.*

[Compiled from official texts on file in Bureau of Foreign and Domestic Commerce, Department of Commerce, and corrected to Jan. 1, 1919.]

Countries.	Tariff No.	Foreign rate.	United States equivalents [1] (dollars per pound).
United States	41		$0.01.
United Kingdom		Free	Free.
France	263	do.	Do.
Germany [2]	317	do.	Do.
Russia [3]	112 (9)	5 roubles + 10 per cent per pood gross	$0.0862.
Italy:			
General tariff	80	10 lire per quintal	$0.0087.
Canada:			
British preferential	711	20 per cent ad valorem	20 per cent ad valorem.
Intermediate	711	35 per cent ad valorem	25 per cent ad valorem.
General [4]	711	do.	Do.
Australia: [5]			
British preferential	281	Free	Free.
General tariff [4 5]	281	5 per cent ad valorem	5 per cent ad valorem.
Japan [3]	229	20 per cent ad valorem	20 per cent ad valorem.

[1] Conversions into United States currency are based on par value.
[2] Metalloids, acids, salts, and combinations of metalloids one with another or with metals, not specified above or elsewhere.
[3] Chemicals, n. o. s.
[4] The general rate is applied to the United States.
[5] Articles, n. o. s.

TABLE XIII.—*Rates of import duties on citric acid in the principal countries.*

[Compiled from official texts on file in the Bureau of Foreign and Domestic Commerce, Department of Commerce, and corrected to Jan. 1, 1919.]

Countries.	Tariff No.	Foreign rate.	United States equivalents [1] (dollars per pound).
United States	1		$0.05.
United Kingdom		Free	Free.
France: [2]			
General tariff [3]	238	75 francs per 100 kilos	$0.0657.
Minimum tariff	238	50 francs per 100 kilos	$0.0438.
Germany:			
General rate	279	8 marks per 100 kilos	$0.0066.
Conventional rate [4]	279	Free	Free.

[1] Conversions into United States currency are based on par value.
[2] Citric acid, crystallized.
[3] General tariff applies to the United States.
[4] Conventional tariff applies to the United States.

TABLE XIII.—*Rates of import duties on citric acid in the principal countries*—Continued.

Countries.	Tariff No.	Foreign rate.	United States equivalents (dollars per pound).
Austria-Hungary:			
General tariff	600	15 per cent ad valorem	15 per cent.
Conventional tariff	600	....do	Do.
Italy: General rate	377	50 lire per quintal	$0.0438.
Japan	160	27.59 yen per 100 kin	$0.1631.
Canada:			
British preferential tariff	216	20 per cent	20 per cent.
Intermediate tariff	216	27½ per cent	27½ per cent.
General tariff [1] [2]	216	30 per cent	30 per cent.
Mexico	515	5 centavos per kilo	$0.011.
Brazil	178	700 reis per kilo	$0.081.
Chili	1,360	50 centavos per kilo	$0.0828.
Argentine	39	7.8 centavos per kilo	$0.0841.
Australia:			
British preferential tariff	279	Free	Free.
General [1]	279	5 per cent ad valorem	5 per cent.

[1] General tariff applies to the United States.
[2] Nitric acid and all other acids n. o. p. f. This includes 5 per cent provisional duty on British preferential and 7½ per cent on intermediate and general.

TARIFF PROBLEMS.

These articles present two distinct tariff problems. The first problem is the general one, whether these articles should be placed on the free list, or subject to a duty for the purpose of raising revenue or for the protection of an American industry. The tariff treatment is necessarily related to that of lemons, the major product of the industry, which are now given a protective duty. There is, however, a difference between the two products—lemons and citric acid—in that lemons are an agricultural product with no mechanical or technical processes, whereas the manufacture of citric acid presents new technical and commercial problems. It may be urged, further, that the full recovery of the by-products will utilize a material formerly wasted and will strengthen the lemon industry without raising the price of lemons to the public. On the other hand, it is not likely that the by-product industry will develop sufficiently to supply the entire American demand unless the duty is made so high as to result in the use of fruit of good enough quality to be salable as fresh fruit and to exclude the by-products from abroad made from cull lemons.

The second problem is the proper relationship between the rates of duty on citrate and citric acid made therefrom. Prior to the passage of the present tariff act citrate of lime was free and the margin in favor of the acid was 7 cents per pound, which shut out the foreign acid almost entirely. The imposition of a duty of 1 cent per pound on citrate of lime did not decrease imports, and it raised over $60,000 revenue per year. At the same time that this duty became effective there was a reduction in the duty on citric acid from 7 cents to 5 cents per pound, and at about the same time there was a development of the manufacture of citric acid in Italy. The result of these changes in competitive conditions was an increase in imports of citric acid to about 15 or 20 per cent of the consumption during 1914 and 1915, an increase sufficient to furnish some competition to the domestic industry. During the last two years there has been a fall in imports, resulting in part at least from war conditions.

There has been little litigation upon these by-products of the lemon-growing industry. Specific provision for citric acid and citrate of lime has obviated litigation.

Effervescent citrate of magnesia, which has not been specifically provided for, was held dutiable as a chemical compound or salt under the act of 1883. (Appeals of Levin et al., T. D. 5949 and 6291.)

Oils have been in issue under several tariff acts. Citral, a highly concentrated and refined form of oil of lemon, from which nearly all terpin constituents had been extracted, was classified as oil of lemon under the act of 1890. (In re Fritzsche, 56 Fed., 819, affirming G. A. 999 (T. D. 12137).)

But so-called concrete essence of lemon, containing 21.43 per cent of lemon oil, was held dutiable as an unenumerated manufactured article rather than as lemon oil under the act of 1909. (In re Ritchie, Abstract 35786 (T. D. 34521).)

Oil of lemon, put up in bottles containing less than 2½ pounds gross weight became the subject of litigation because of the provision in paragraph 17 of the act of 1913, making dutiable thereunder chemical and medicinal compounds or combinations, and all similar articles dutiable under section 1 of that act, except soap whether specially provided for or not, put up in individual packages of 2½ pounds or less gross weight. The Treasury Department at first construed this provision to embrace all articles provided for in schedule A, whether eo nomine or otherwise, except soap and sponges. (Department Order, T. D. 34035.) But upon further investigation the department reached the conclusion that oil of lemon, among other oils, did not fall within paragraph 17, not being similar to chemical and medicinal compounds or combinations. (T. D. 34184.)

The Court of Customs Appeals concurred in this construction in a case arising upon sweet almond oil and castor oil. (Monticelli Bros. *v.* United States, 8 Ct. Cust. Appls., 21–7, T. D. 37162.) The phrase "medicinal compounds, combinations, and all similar articles" was interpreted to mean (1) strictly medical compounds and combinations, and (2) compounds or combinations similar thereto in that, although not strictly medical, because possessing properties adapting them to other uses, are nevertheless susceptible of medicinal uses, and in the form and condition imported are specially designed therefor and chiefly so used.

There has been considerable litigation upon lemon and sour orange juice. Before specific provision was made for sour orange juice (in the act of 1890), it was classified as lemon or lime juice by similitude. (Appeals of Powers & Weightman et al., T. D. 2345 of 1875 and 6589 of 1884.)

Bitter or sour orange juice, containing more than 2 per cent of alcohol, the maximum allowed in paragraph 532 of the act of 1913 for free entry, was held dutiable as fruit juice containing not more than 18 per cent of alcohol. (In re Lackey, Abstract 40453.)

Fortified lemon juice, produced by the addition of 7.5 per cent of absolute alcohol to ordinary lemon juice, was classified as lemon

juice and not as an alcoholic compound under the act of 1883 (Morrell *v.* United States, reported in T. D. 26819, reversing G. A. 604 (T. D. 11245)), and in effect overruling T. D. 8948, holding fortified lime juice containing 7½ per cent of alcohol dutiable as an alcoholic compound and not as lime juice under that act. The Morrell case was acquiesced in by the Treasury Department in T. D. 13008, and followed by the Board of General Appraisers in G. A. 1653 (T. D. 13232), in exempting from duty under the act of 1890, lemon and lime juice in bottles fortified with not more than 10 per cent of alcohol.

On the other hand, a combination of lime juice and sirup was held dutiable as an unenumerated manufactured article, rather than as lime juice under the act of 1883. (Appeal of Rich Co., T. D. 9709.)

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THE FORMIC-ACID INDUSTRY.

The tariff act of 1913 contains the following provisions:

Par. 1. * * * formic acid, 1½ cents per pound; * * *.

No other salts or compounds of formic acid are specially mentioned, but the law contains the following provision:

Par. 5. Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof not specifically provided for in this section, 15 per centum ad valorem.

DESCRIPTION.

Formic acid is a useful material in the dyeing and tanning industries, but other competing acids have, as a rule, been cheaper and the use of formic acid has therefore been restricted to a few cases for which it has peculiar advantages. It is chiefly of interest because recent technical advances in its manufacture indicate that when normal industrial conditions are restored, it may be put on the market at a lower price, which should greatly broaden its market. These new discoveries will probably indirectly have a marked influence also on the manufacture of oxalic acid.

Formic acid when concentrated is a corrosive, fuming, colorless liquid with a characteristic and irritating odor. It solidifies at 8° C., and has a boiling point almost identical with that of water. It mixes with water in all proportions and appears in commerce in strengths varying from about 50 per cent up to almost 100 per cent. It is a stronger acid than acetic acid, which it resembles most closely, and has antiseptic properties. Formic acid produces a painful sore when brought in contact with the skin. The irritation caused by the sting of bees and wasps is believed to be due to the minute amount of formic acid secreted in the wound. Its alkali salts are reducing agents, particularly at high temperatures.

USES.

The textile industry can use formic acid for many purposes. In the dyeing of cotton and wool mixtures in acid bath it is said to be superior to sulphuric acid because it is less injurious to cotton than sulphuric acid. It is also used as a mordanting assistant in dyeing wool with a chrome mordant, for which purpose it competes with tartaric, oxalic, and lactic acids. It may replace acetic acid for many purposes in the textile mill whenever the price will justify it.

Formic acid has been used to some extent in tanneries as a substitute for the bran drench for removing lime from hides, but unless

the price can be greatly reduced it is not likely to prove a serious competitor with lactic acid for the purpose.

In some distilleries small amounts of formic acid are added to the acidified mash. It is said that formic acid stimulates the activity of the yeast and represses the activity of the acid-forming bacteria, thereby increasing the yield and purity of the alcohol.

Formic acid forms salts with all metals, but the most important derivative is sodium formate. It is the material from which formic acid is made and is also used for the manufacture of oxalic acid. Nickel formate is used as a catalytic agent in the hydrogenation of oils. Many different forms of nickel are used for this process, but it is claimed that the formate has many advantages and a large and growing use is indicated.

Formic acid forms many esters, including methyl formate, ethyl formate, butyl formate, and amyl formate. These are useful as perfumes and solvents. Cellulose formate, although not yet commercially developed, may prove an important rival for cellulose acetate and nitrate in the manufacture of plastics, lacquers and coatings for aeroplane wings. A derivative of formic acid known as diphosgene (perchlormethyl formate) was used by the Germans in poison-gas warfare. It can be prepared from formic acid, methyl alcohol and chlorine or from phosgene, methyl alcohol and chlorine.

PROCESS OF MANUFACTURE.

The earliest method of making formic acid was by the distillation with water of the bodies of certain varieties of ants. The name of the acid is derived from this source (*formica*, Latin for ant). Formic acid was next made by heating together oxalic acid and glycerine, but the acid made in this way was too expensive to find wide use. The development of the Goldschmidt process, by the Germans, reduced the cost of formic acid considerably and made it possible for the industry to grow rapidly. This process consists in heating carbon monoxide (or a gas rich in carbon monoxide such as producer gas) with caustic soda, under a pressure of about 10 atmospheres, and at a temperature of about 200° C. This results in a direct combination, yielding sodium formate of a high degree of purity. The sodium formate may be treated with an acid (sulphuric acid or niter cake) and distilled, yielding formic acid. An even more important development is the conversion of the sodium formate into sodium oxalate and oxalic acid (see p. 61).

INTERNATIONAL TRADE.

The development of this process in Germany gave to Germany a dominant position in the industry throughout the world. The only American manufacturer of formic acid before the outbreak of the European war was the Merrimac Chemical Co. of Boston, who for some time operated under their own and foreign patents. With the changed conditions, however, due to the war, they discontinued making this product and are not now making formic acid.

IMPORTS.

Imports of formic acid are shown in the following table. Statistics on imports of sodium formate are not shown in Commerce and Navigation reports.

TABLE I.—*Imports of formic acid for consumption in the United States, 1906–1919.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1906	25 per cent	58,305	$4,036	$1,009	$0.069	25.00
1907	do	215,921	13,768	3,442	.064	25.00
1908	do	335,483	24,217	6,054	.072	25.00
1909	do	809,444	57,329	14,332	.071	25.00
1910	do	769,712	53,690	13,422	.070	25.00
1911	do	964,345	63,171	15,793	.065	25.00
1912	do	678,524	30,674	7,668	.045	25.00
1913	do	502,685	22,414	5,603	.045	25.00
1914[1]	do	74,901	3,610	902	.048	25.00
1914[2]	1½ cents per pound	1,044,844	45,216	15,673	.043	34.66
1915	do	534,895	30,641	8,023	.057	26.19
1916	do	131,719	19,627	1,976	.149	10.07
1917	do	385,463	95,074	5,782	.246	6.08
1918	do					
1919	do					
1919 (calendar year)	do	132,333	29,604	1,985	.224	6.70

[1] Act of 1909, July 1, 1913, to Oct. 3, 1913. [2] Act of 1913, Oct. 4, 1913, to June 30, 1914.

The imports of formic acid during the fiscal year ending June 30, 1914, were derived from the following sources: Germany, 85.7 per cent; Netherlands, 9.3 per cent; England, 2.7 per cent; and Belgium, 2.3 per cent. During the fiscal year 1914, imports of sodium formate (commercial) were 1,843,245 pounds, valued at $44,693, almost entirely (99.9 per cent) from Germany and 661 pounds of chemically pure sodium formate valued at $135.[1]

THE INDUSTRY IN THE UNITED STATES.

Since the outbreak of the European war there have been several developments or discoveries in the United States which may result in the creation of an American industry. The Rosebrugh Chemical Corporation of Syracuse, N. Y., has been developing the manufacture of formic acid and selling this acid since the early part of 1918. The Pennsylvania Trojan Powder Co., of Allentown, Pa., is making sodium formate on a commercial scale, but is not yet making either formic acid or oxalic acid. E. C. Klipstein & Sons, of South Charleston, W. Va., manufacture formic acid on a commercial scale from sodium formate. The Victor Chemical Co. of Chicago has been developing the manufacture of oxalic acid by a process which makes sodium formate as an intermediate product. This company is, therefore, in an advantageous position to make formic acid if the market conditions justify it.

[1] Chemicals and allied products used in the United States, Department of Commerce, Miscellaneous Series No. 82.

Formic and oxalic acids are likely to be made by an entirely new process invented and being developed by Americans. Mr. J. E. Bucher has patented a process for making sodium cyanide by passing nitrogen gas over a heated mixture of soda ash, carbon, and iron. The development of this process was undertaken by the Nitrogen Products Co., which erected an experimental plant at Saltville, Va. A large plant capable of producing 10 tons of sodium cyanide a day was completed during the latter part of 1918 by the Bureau of Mines for the War Department at one of its series of plants built in connection with gas warfare. This appears to be a more advanced process for making cyanides than the methods which have been in commercial use. When some rather difficult problems in chemical engineering are solved this process may be expected to replace the older methods and to make sodium cyanide available at a lower price and in amounts limited only by the demand. Moreover, sodium cyanide can be converted into sodium formate and ammonia by treatment with live steam. The sodium formate may be converted into formic or into oxalic acid by well-known means.

The Air Reduction Co. of Jersey City, N. J., has developed and is now operating on a considerable scale, a process for nitrogen fixation in which the nitrogen is fixed primarily as a cyanide. The cyanide is decomposed by means of steam yielding ammonia, or ammonium salts and formates. The formates are worked up into formic acid and formic esters. Progress on the commercial development of formic-acid production was considerably hampered by the war, but they expect soon to have this work well under way.

The commercial development of most of these projects during the war was hindered by the fact that formic acid was not regarded as an essential war commodity, and materials and men for the development of these projects were, therefore, lacking. A rapid development of an American formic-acid industry from some or all of these sources may now be expected.

TARIFF HISTORY.

Formic acid was first mentioned by name in the tariff act of 1913, which imposed a duty of 1½ cents a pound.

Act of—		Tariff classification or description.	Rates of duty specific and ad valorem.
Year.	Paragraph.		
1890..	473	N. s. p. f. Acids used for medicinal, chemical, or manufacturing purposes, not specially provided for in this act.	Free.
1894..	363	N. s. p. f. Same classification as in 1890	Do.
1897..	1	N. s. p. f. * * * all other acids not specially provided for in this act, 25 per centum ad valorem.	25 per cent.
1909..	1	N. s. p. f. Same classification as in 1897	Do.
1913..	1	* * * formic acid * * *	1½ cents per pound.

TABLE II.—*Rates of import duties on formic acid in principal countries.*

[Compiled from official texts on file in Bureau of Foreign and Domestic Commerce, Department of Commerce, and corrected to Jan. 1, 1919.]

Countries.	Tariff No.	Foreign rate.	United States equivalents[1] (dollars per pound).
United States	1		$0.015.
United Kingdom		Free	Free.
France:			
General tariff[2]—			
60 per cent or less[3]	238	22 francs per 100 kilos	$0.0192.
More than 60 per cent[4]	238	25 francs per 100 kilos	$0.0218.
Minimum tariff—			
60 per cent or less[3]	238	15 francs per 100 kilos	$0.0131.
More than 60 per cent,[4]	238	18 francs per 100 kilos	$0.0157.
Germany[5]	390	Free	Free.
Russia	112(9)	5 roubles+10 per cent per pood	$0.0862.
Italy[6]	37v	10 lire per metric quintal	$0.0087.
Canada:[7]			
British preferential	216	20 per cent ad valorem	20 per cent ad valorem.
Intermediate	216	27½ per cent ad valorem	27½ per cent ad valorem.
General[8]	216	30 per cent advalorem	30 per cent ad valorem.
Australia[5]	281ex		
General[8]		5 per cent ad valorem	5 per cent ad valorem.
British preferential		Free	Free.
Japan	229ex	20 per cent ad valorem	20 per cent ad valorem.

[1] Conversions into United States currency are based on par value.
[2] The general rate is applied to the United States.
[3] Containing 60 per cent or less by weight of free acid.
[4] Containing more than 60 per cent by weight of free acid.
[5] Chemicals, n. o. s.
[6] Acids, n. o. s.
[7] All other acids, n. o. s.
[8] The general rate applies to the United States.

TARIFF PROBLEMS.

The advisability of providing specifically for sodium formate in the tariff law should be considered. Since sodium formate is used primarily as an intermediate substance for the manufacture of formic and oxalic acids, its importation on a large scale means that the American formic and oxalic industries are becoming dependent on foreign semi-manufactured materials in spite of the fact that the fundamental raw materials, caustic soda and coke, are available in the United States.

Should the Congress desire to insure that the American formic-acid and oxalic-acid industries should become independent of imported semi-manufactured or intermediate materials, this might be accomplished by placing a relatively high duty on sodium formate. A duty on sodium formate would not require a compensatory duty on formic and oxalic acids since its effect would be to force the manufacture of the intermediate substance as a part of the manufacture of the finished acids.

The German dominance of the industry in the past has been due to the fact that the modern process was invented and declared in Germany, thus giving the German manufacturers a great advantage in knowledge and experience with the details of the process and a low overhead expense due to a large established business. These factors, rather than lack of essential raw materials at competitive prices, have made it difficult to establish the industry in the United States under competitive conditions. The industry, however, got a start

in the United States during the war and after gaining in experience should be able to maintain itself without unusually high duties on the finished products. The consumers of formic and oxalic acids would not be permanently disturbed by a prohibitive duty on sodium formate, which would merely require that the American industry make itself independent of any foreign raw materials.

This case is quite different from that of the tannic-acid and tartaric-acid industries. These industries are dependent on essential raw materials (nutgalls and argols) which must be imported and, therefore, any duty on the raw materials, unless accompanied by a compensatory duty on tannic acid or tartaric acid would threaten the existence of the American industry and, moreover, any duty on the raw materials would naturally cause a corresponding increase in the cost of the finished acids as long as it remains in effect.

THE GALLIC, PYROGALLIC, AND TANNIC ACIDS INDUSTRY.

The articles discussed in this chapter are provided for in the following paragraphs of the tariff act of 1913:

Par. 1. * * * gallic acid, 6 cents per pound; pyrogallic acid, 12 cents per pound; * * * tannic acid and tannin, 5 cents per pound; * * *.

Par. 30. Extracts and decoctions of nutgalls; * * * all the foregoing not containing alcohol and not medicinal, three-eighths of 1 cent per pound.

Par. 624 (free list). Tanning material: nuts and nutgalls, and woods used expressly for dyeing or tanning, whether or not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process, * * * all the foregoing not containing alcohol and not specially provided for in this section.

DESCRIPTION AND USES.

The tannins are a large class of substances which have the power of combining with hide and thereby converting it into leather. They occur widely scattered in the vegetable kingdom and may be divided into two classes depending upon whether their formation is physiological or pathological. The physiological tannins occur naturally in the wood, bark, leaves, fruits, and seed pods of many plants. When soaked in water, these materials yield extracts that find extensive use for tanning. The extracts contain in addition to the tannin many other substances, including coloring matters, resins, and carbohydrates from which the tannin can only be separated with great difficulty. These non-tannin substances, however, do little or no harm or in some cases may even be advantageous and ordinarily no attempt is made to prepare a pure tannin from these extracts. The crude extracts used for tanning and dyeing are not discussed in detail in this report. The pathological tannins are formed on plants following the sting and deposition of eggs by insects which causes pathological growths known as galls, or gallnuts or nutgalls. These nutgalls contain a high percentage of tannin and are the best raw material for the manufacture of pure tannin or tannic acid. Tannic acid finds important uses in the textile and chemical industries, but is not used commercially for the tanning of leather. Gallic and pyrogallic acids serve quite different uses but are made from tannic acid, and are, therefore, conveniently discussed with it. Since the fundamental raw material is not produced in significant amounts in the United States the industry is dependent on foreign supplies, which come chiefly from two sources, China and Asia Minor.

Nutgalls or gallnuts or galls are excrescences or pathological growths produced on certain plants by the deposition of eggs by certain insects. The larvæ of the insect grow within this shell and eventually the insect pierces the shell and escapes.

Chinese and Japanese nutgalls grow on a species of sumac owing to the deposition of eggs of the insect *Alphis chinensis*. They are hollow shells of irregular shape about the size of a walnut, and contain 60 to 70 per cent of tannic acid.

Turkish nutgalls, commonly called Aleppo galls, are produced on young shoots of an oak following the deposition of eggs of a wasp-like insect, *Cynips*.

Some galls are also produced in northern European countries but these are of relatively little importance.

The terms, tannic acid and tannin, when used in commerce refer to what is, chemically, gallotannic acid. Tannic acid appears in commerce in two grades, one a highly purified form conforming to the specification of the United States Pharmacopoeia known as tannic acid U. S. P., and the other a less pure or technical grade. It is a noncrystalline solid, white when pure, but yellow, grey, or brown if impure, and is readily soluble in water.

Tannic acid gives insoluble precipitates with the salts of many metals, especially tin, iron, chromium, and antimony. This property is much utilized in dyeing textiles and furs since such compounds of tannin and metal have a strong affinity for many dyes. Another important use is in the manufacture of ink.

Lesser uses of tannic acid are in the manufacture of some color lakes, in the clarification of wines and some fruit juices and in pharmacy, and as raw material for the manufacture of gallic acid and pyrogallic acid.

The extracts and decoctions of nutgalls are water solutions made from nutgalls containing tannic acid as their essential ingredient or a solid obtained by the evaporation of such solutions. There is no sharp and well-defined distinction between the technical grade of tannic acid or tannin and a solid extract of nutgalls, although as a rule the term, tannic acid, is applied to better grades than the term, extract of nutgalls.

Gallic acid, or trihydroxybenzoic acid, is contained in many tanning extracts, but is obtained commercially from tannic acid or direct from nutgalls. It is a white crystalline substance when pure and is used chiefly for the manufacture of dyes, pyrogallic acid, and ink, and in medicine. Gallic acid has played an important part in the development of the new American dye industry since it is used in the manufacture of Gallocyanine Blue, which has been much used for dyeing the wool used in navy uniforms.

Pyrogallic acid, or pyrogallol, or trioxybenzol, is a white crystalline solid made by heating gallic acid. It is the oldest of the photographic developers and is probably the most used. Pyrogallol itself and several products made therefrom are used in medicine. Another use is for the dyeing of fur and hair and for staining wood. Pyrogallol is an important reagent in the chemical laboratory being used as an absorbent for oxygen gas in gas analysis.

PROCESS OF MANUFACTURE.

Nutgalls are the most satisfactory raw material. The nutgalls vary in quality according to the region of origin and the time of collection. They are of better quality and richer in tannic acid if col-

lected before the insect escapes. Good quality nutgalls contain up to 70 per cent of tannic acid.

There are several methods of preparing tannic acid. In one process the nuts are extracted with water and the solution filtered from insoluble matter and then extracted with ether, which removes much of the impurities without removing any tannic acid, followed by the evaporation and drying of the tannic-acid solution.

Another process is to extract the galls with dilute denatured alcohol, which dissolves the tannic acid, together with some other materials. The alcohol is recovered by distillation and the residue treated with chemicals, which assist in the elimination of resinous impurities. The aqueous solution is then evaporated to dryness yielding technical tannic acid.

There is still another method similar to the above which depends on the use of acetone as a solvent instead of denatured alcohol.

To prepare pure tannic acid U.S.P., the technical grade may be dissolved in water and precipitated as the lead salt by the addition of acetate of lead. The precipitate is then washed, filtered, suspended in water, and decomposed with hydrogen sulphide, yielding insoluble lead sulphide and a solution of tannic acid, which is then filtered and evaporated to dryness.

Gallic acid may be made from tannic acid but is usually obtained directly from nutgalls. The crushed nutgalls are moistened and exposed to air, whereupon they become covered with a mold which by fermentive action decomposes the tannic acid to form gallic acid. Gallic acid may also be obtained from the nutgalls by heating them with a dilute solution of sulphuric acid. The gallic acid is extracted with hot water and purified by crystallization. Gallic acid differs from tannic in that it can be crystallized from water.

Pyrogallic acid is made from gallic acid by heating to about 200° C. in a glycerine solution or heating in aqueous solution in an autoclave. The resulting pyrogallol solution is decolorized and evaporated and the pyrogallol recovered by crystallization. It may be purified by sublimation.

TANNIC ACID.

Production.—According to the Federal census the production of tannic acid in the United States during 1914 was 853,830 pounds, valued at $287,142 made by five firms.

The following table, compiled from reports submitted to the Tariff Commission by manufacturers, gives the production of tannic acid during 1915, 1916, and 1917:

	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Tannic acid technical	583,445	$246,118	622,393	$312,105	555,301	$328,381
Tannic acid United States Pharmacopœia	198,042	138,800	180,303	163,554	196,742	226,325

The following firms are manufacturers of tannic acid in the United States: F. Bredt & Co., New York City; Mallinckrodt

Chemical Works, St. Louis, Mo.; Powers-Weightman-Rosengarten Co., Philadelphia, Pa.; Zinsser & Co., Hastings upon Hudson, New York.

Imports.—The imports of the tannin materials into the United States are shown in the following tables:

TABLE I.—*Imports for consumption of nutgalls and nuts for tanning and dyeing, 1912–1919.*

Fiscal years.	Values.	Fiscal years.	Values.
1912	$129,457	1917	$214,653
1913	126,435	1918	872,173
1914	177,788	1919	362,975
1915	137,972	1919 (calendar year)	135,985
1916	420,030		

TABLE II.—*Imports for consumption of nutgalls, extract and decoction for dyeing, 1912–1919.*

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1912	½ cent per pound plus 10 per cent.	148,701	$16,144	$1,986	$0.109	12.30
1913	do	145,919	18,228	2,187	.125	12.00
1914[1]	do	47,845	5,899	709	.123	12.03
1914[2]	½ cent per pound	157,285	19,118	589	.122	3.09
1915	do	157,084	23,262	589	.148	2.53
1916	do	61,055	11,444	228	.187	2.00
1917	do	45,760	9,867	171	.215	1.74
1918	do	36,475	12,761	137	.349	1.07
1919	do	34,033	12,058	128	.354	1.06
1919 (calendar year)	do	47,608	25,280	178	.531	.71

[1] From July 1 to Oct. 3, 1913. [2] From Oct. 4, 1913, to June 30, 1914.

TABLE III.—*Imports of tannic acid or tannin for consumption, 1910–1919.*

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	50 cents per pound	125	$407	$63	$3.26	15.36
	35 cents per pound	8,071	3,864	2,825	.478	73.10
1911	do	5,755	2,250	2,014	.391	89.52
1912	do	1,010	484	353	.479	73.04
1913	do	1,540	768	539	.499	70.18
1914[1]	do	258	112	90	.434	80.63
1914[2]	5 cents per pound	12,634	4,214	632	.334	14.99
1915	do	49,493	17,047	2,475	.344	14.52
1916	do	2,229	684	111	.308	16.29
1917	do	160	41	8	.256	19.51
1918	do	5,432	1,424	272	.262	19.07
1919	do	96,831	41,675	4,841	.431	11.61
1919 (calendar year)	do	68,336	31,470	3,417	.461	10.86

[1] From July 1 to Oct. 3, 1913. [2] From Oct. 4, 1913, to June 30, 1914.

Imports of tannic acid during the fiscal year ending June 30, 1914, were derived from the following sources: Germany, 90.6 per cent; France, 9.4 per cent.

It is apparent that under the tariff act of 1909, which imposed a duty of 35 cents per pound, the imports were negligible, being only about 0.2 per cent of the American production. The tariff act of 1913 reduced the duty from 35 cents to 5 cents per pound. Imports rose to 12,892 pounds during the fiscal year ending June 30, 1914, and to 49,493 pounds, valued at $17,047, during the fiscal year ending June 30, 1915, and then again became negligible. The imports at their maximum may therefore be estimated at about 6 per cent of the total American production.

However, although the import statistics do not distinguish between the technical and United States Pharmacopœia grades, information has been received from persons familiar with the trade that the tannic acid imported was almost entirely the United States Pharmacopœia grade. The imports at their maximum were about one-quarter of the American production of the United States Pharmacopœia grade.

The following table gives the German imports and exports of tannic acid and gallic acid:

TABLE IV.—*Imports and exports of tannic acid and gallic acid for Germany, 1910–1913.*[1]

Year.	Exports from Germany.		Imports into Germany.	
	Pounds.	Value.	Pounds.	Value.
1910	2,087,536	$676,158	210,319	$45,458
1911	2,078,497	554,540	249,340	53,788
1912	1,664,693	459,816	326,501	70,448
1913	1,720,470	491,232	256,615	60,928

[1] Source: Vierteljahrshefte zur Statistik des Deutschen Reichs.

GALLIC ACID.

Production.—The following table, compiled from reports submitted to the Tariff Commission by manufacturers, gives the production of gallic acid for 1915, 1916, and 1917:

TABLE V.—*Production of gallic acid (technical and United States Pharmacopœia) in United States, 1915–1917.*

ear.	Pounds.	Value.
1915	345,572	$191,665
1916	1,002,485	732,472
1917	1,227,982	1,140,279

The large increase in the production of gallic acid is due primarily to the growth of the American dye industry which has consumed much gallic acid in the manufacture of dyes.

The American producers are: The Eastman Kodak Co., Rochester, N. Y.; Mallinckrodt Chemical Works, St. Louis, Mo.; National Aniline & Chemical Co., New York City; Zinsser & Co., Hastings-on-Hudson, N. Y.

Imports.—The imports of gallic acid are shown in the following table:

TABLE VI.—*Imports of gallic acid for consumption in the United States, 1910–1919.*

Fiscal year.	Rates of duty.	Quantities.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	10 cents per pound	1,102	$263	$110	$0.239	41.90
1910	8 cents per pound	78,162	23,205	6,252	.297	26.95
1911	do	45,964	13,861	3,677	.302	26.53
1912	do	28,917	9,701	2,313	.335	23.84
1913	do	51,326	17,086	4,106	.333	24.03
1914 [1]	do	4,589	1,557	367	.339	23.58
1914 [2]	6 cents per pound	57,046	18,872	3,423	.331	18.14
1915	do	41,558	14,992	2,493	.361	16.62
1916	do	5,101	1,965	306	.385	15.58
1917	do					
1918	do	8,643	9,708	519	1.123	5.35
1919	do	22	26	1	1.18	4.54
1919 (calendar year)	do	22	26	1	1.18	4.54

[1] Act of 1909, July 1, 1913, to Oct. 3, 1913. [2] Act of 1913, Oct. 4, 1913, to June 30, 1914.

Imports of gallic acid during the 1914 fiscal year came entirely from Germany.

PYROGALLIC ACID.

Production.—The following table, compiled from reports submitted to the Tariff Commission by manufacturers, gives the production of pyrogallic acid for 1915, 1916, and 1917:

TABLE VII.—*Production of pyrogallic acid in the United States, 1915–1917.*

Year.	Pounds.	Value.
1915	97,848	$113,878
1916	144,832	261,158
1917	205,308	539,710

The following firms are manufacturers of pyrogallic acid in the United States: Eastman Kodak Co., Rochester, N. Y.; Mallinckrodt Chemical Works, St. Louis, Mo.; Zinsser & Co., Hastings-on-Hudson, N. Y.

Imports.—The imports of pyrogallic acid have been a much larger proportion of the American production than in the case of either tannic or gallic acids.

TABLE VIII.—*Imports of pyrogallic acid for consumption in the United States, 1910–1919.*

Fiscal year.	Rates of duty.	Quantities.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	25 per cent	37,167	$25,260	$6,316	$0.68	25.00
1911	do	22,145	14,188	3,547	.641	25.00
1912	do	28,961	22,804	5,701	.787	25.00
1913	do	9,512	9,278	2,320	.975	25.00
1914 [1]	do	196	181	45	.92	25.00
1914 [2]	12 cents per pound	23,419	20,315	2,810	.867	13.83
1915	do	10,564	9,514	1,267	.901	13.32
1916	do	169	227	20	1.345	8.93
1917						
1918	12 cents per pound	275	547	33	1.98	6.03
1919	do					
1919 (calendar year)	do					

[1] Act of 1909, July 1, 1913, to Oct. 3, 1913. [2] Act of 1913, Oct. 4, 1913, to June 30, 1914.

Germany supplied 99.9 per cent of the imports of pyrogallol during the fiscal year ending June 30, 1914.

PRICES.

The price of technical tannic acid was exceptionally steady at 30 to 35 cents per pound for several years before the passage of the tariff act of 1913. The price rose to 70 cents at the outbreak of the European war but soon declined again to 45 cents during the fall of 1915 and the early part of 1916. During the summer of 1918 prices rose to a new high level of 80 to 90 cents, but have since fallen to 65 cents. Technical tannic acid is thus one of the few commodities which has not shown a considerable rise during the war.

The price of tannic acid U. S. P. has advanced recently more than the technical grade. During 1912 and 1913, until the passage of the tariff act of 1913, the price was steady at 78 to 80 cents. The price dropped about 20 cents following the passage of the tariff act of 1913. It has since risen to about $1.40, which is about twice the price of the technical acid.

The following table shows the price of technical and U. S. P. tannic acid as quoted in the Oil, Paint and Drug Reporter:

TABLE IX.—*Wholesale prices of tannic acid at New York.*

[Cents per pound, spot.]

Date.	Technical.	United States Pharmacopœia.	Date.	Technical.	United States Pharmacopœia.
Jan. 1, 1912[1]		78–80	Jan. 3, 1916	45–50	80– 81
Apr. 1, 1912		78–80	Apr. 3, 1916	60–63½	100–106
July 1, 1912		78–80	July 3, 1916	60–63½	100–106
Sept. 30, 1912		78–80	Oct. 2, 1916	65–80	100–106
Dec. 30, 1912		78–80	Jan. 1, 1917	65–80	95–100
Mar. 31, 1913		78–80	Apr. 1, 1917	65–80	95– 95
June 30, 1913		78–80	July 1, 1917	80–95	125–130
Sept. 29, 1913		78–80	Oct. 1, 1917	80–95	130–135
Dec. 29, 1913		57–60	Jan. 1, 1918	55–70	130–140
Mar. 30, 1914	50–51	55–56	Apr. 1, 1918	55–60	130–140
June 29, 1914	50–51	55–56	July 1, 1918	60–65	140–145
Sept. 28, 1914	70–71	75–76	Oct. 7, 1918	65–80	140–150
Dec. 28, 1914	70–71	75–76	Jan. 6, 1919	65–80	140–150
Mar. 29, 1915	65–66	65–66	Apr. 1, 1919	65–80	140–150
June 28, 1915	65–66	65–66	July 1, 1919	45–60	130–140
Sept. 27, 1915	45–50	80–81	Oct. 1, 1919	60–85	135–143

[1] Prices during 1912 and 1913 for technical tannic acid averaged 30 to 35 cents per pound.

TABLE X.—*Wholesale prices of pyrogallic acid (resublimed) at New York.*

[Dollars per pound, spot.]

Jan. 1, 1912	1.35–1.45	Jan. 3, 1916	1.25–1.45
Apr. 1, 1912	1.35–1.45	Apr. 3, 1916	2.50–2.55
July 1, 1912	1.35–1.45	July 3, 1916	2.75–2.95
Sept. 30, 1912	1.35–1.45	Oct. 2, 1916	2.90–3.20
Dec. 30, 1912	1.35–1.45	Jan. 1, 1917	3.25
Mar. 31, 1913	1.20–1.40	Apr. 1, 1917	3.25
June 30, 1913	1.20–1.40	July 1, 1917	3.25
Sept. 29, 1913	1.20–1.40	Oct. 1, 1917	3.25
Dec. 29, 1913	1.20–1.40	Jan. 1, 1918	3.15–3.25
Mar. 30, 1914	1.20–1.40	Apr. 1, 1918	3.10
June 29, 1914	1.20–1.40	July 1, 1918	3.10
Sept. 28, 1914	2.50	Oct. 7, 1918	3.25–3.50
Dec. 28, 1914	1.90–2.00	Jan. 6, 1919	3.25–3.50
Mar. 29, 1915	1.35–1.55	Apr. 1, 1919	2.70–3.00
June 28, 1915	1.35–1.55	July 1, 1919	2.35–....
Sept. 27, 1915	1.25–1.45	Oct. 1, 1919	2.35–....

Prices on gallic acid (U. S. P.) have been quoted only since 1915. From that time to January, 1920, the price about doubled. The following table gives the price of gallic acid:

TABLE XI.—*Wholesale prices of gallic acid (U. S. P.) at New York.*

[Dollars per pound, spot.]

April, 1915	0.75–0.80	October, 1917	1.50–1.52
July, 1915	.75– .80	January, 1918	1.55–1.60
October, 1915	.85– .90	April, 1918	1.55–1.60
January, 1916	.85– .90	July, 1918	1.55–1.60
April, 1916	1.25	October, 1918	1.60–1.65
July, 1916	1.35	January, 1919	1.60–1.65
October, 1916	1.28–1.30	April, 1919	1.00–1.15
January, 1917	1.28–1.30	July, 1919	1.15–1.45
April, 1917	1.30–1.50	October, 1919	1.15–1.45
July, 1917	1.30–1.50	January 1, 1920	1.40–1.50

TARIFF HISTORY.

The rates of duty since 1897 are shown in the following table:

Act of	1897	1909	1913
Nutgalls, crude, not advanced.	Free	Free	Free.[1]
Nutgalls, advanced	½ cent per pound plus 10 per cent.	½ cent per pound plus 10 per cent.	Free.
Extracts	N. s. p. f.	...do	½ cent per pound.
Tannic acid	50	35	5 cents per pound.
Gallic acid	10	8	6 cents per pound.
Pyrogallic acid	N. s. p. f. 25 per cent	N. s. p. f. 25 per cent	12 cents per pound.

[1] Whether or not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process.

TARIFF PROBLEMS.

These industries are necessarily dependent on imported raw materials. The crude raw materials have been on the free list in all tariff laws since 1857. If Congress should desire to raise revenue by a duty on nutgalls a compensatory duty on extracts and decoctions of nutgalls, tannic acid, gallic acid, and pyrogallic acid would be logical.

The adjustment of the rates on extracts and decoctions of nutgalls and on tannic acid should also be carefully considered.

The distinction between tannic acid and nutgall extracts and the classification of "extracts of nutgalls" has occasioned much litigation under the tariff acts and several changes in phraseology in succeeding tariff acts. For the present purpose it will be sufficient to begin the discussion with the tariff act of 1894 which did not specifically mention extracts of nutgalls. Under this act a solid desiccated extract of nutgalls was classified by the General Appraisers as tannic acid or tannin (T. D. 17354). There is nothing to show how a liquid extract was classified at that time. The act of 1897 contained a provision for "* * * nutgalls * * * advanced in value or condition by refining, grinding, or other process * * *" but the Treasury Department held (Mar. 7, 1898) that this provision did not cover aqueous extracts of nutgalls which were classified as an unenumerated manufactured article dutiable at 20 per cent (T. D. 19052). On June

11, 1900 (T. D. 22278) while the same act was in force, it was decided by the General Appraisers that extract of nutgalls should be classified directly or by similitude as nutgalls advanced in condition at a duty of one-fourth cent per pound plus 10 per cent. The same year the Treasury Department changed to this classification (T. D. 22529). Three years later, however, the General Appraisers reversed themselves and classified an aqueous extract of nutgalls as "tannic acid" (T. D. 24395). This decision was, however, reversed by the United States Circuit Court for the District of Massachusetts (T. D. 26544, Proctor *v.* United States, 139 Fed., 586), which decided that aqueous extracts should be classified as "nutgalls * * * advanced in value or condition" dutiable at one-fourth cent per pound plus 10 per cent. This decision was affirmed by the United States Circuit Court of Appeals (145 Fed., 126, T. D. 27115).

This classification was evidently accepted by Congress in so far as it applied to aqueous extract of nutgalls and definitely written into the tariff act of 1909 which contains a provision (par. 22) for "* * * extracts of nutgalls, aqueous, one-fourth of 1 cent per pound plus 10 per centum ad valorem * * *." This is the same rate as was imposed upon "* * * nutgalls * * * which are advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the drugs and the prevention of decay or deterioration pending manufacture."

The act of 1913 changed the language so that it reads (par. 30) "Extracts and decoctions of nutgalls * * * all of the foregoing not containing alcohol and not medicinal, three-eighth cent per pound."

The omission of the word aqueous, which appeared in the act of 1909, has broadened its scope so that a solid obtained by the evaporation of a liquid extract may be classified under this provision. Under this provision the distinction between "tannic acid" and a solid "extract of nutgalls" is not clearly defined. The effect is clearly evident in the statistics of imports (see p. 44).

In 1912 the average declared value of the extract was $0.109 per pound with duty equivalent to 12.3 per cent, whereas the average declared value of the tannic acid was $0.479 per pound with a duty equivalent to 73 per cent. This indicates that there was marked difference in the quality of the products, the extract being more dilute or more impure, or both. After the passage of the act of 1913 the declared value of the extract has increased and of the tannic acid has decreased until in 1918 the declared value of the extract actually exceeded the declared value of tannic acid. In 1918 the declared value of the extract was $0.349 with a duty equivalent to 1.07 per cent and the declared value of the tannic acid was $0.262 with a duty equivalent to 19 per cent. There has evidently been a marked change in the character of the merchandise imported under these provisions.

Very recently merchandise which was claimed to be extract of nutgalls and on analysis showed 78.34 per cent of tannic acid was held on the record without evidence of the manufacturing process to be dutiable as tannic acid. (G. A. 8291, T. D. 38151 of 1919; affirmed, T. D. 38555 of 1920.)

THE LACTIC-ACID INDUSTRY.

The articles discussed in this chapter are covered by the tariff act of 1913, in the following paragraphs:

Par. 1. * * * lactic acid, 1½ cents per pound; * * *.

Par. 5. Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof not specially provided for in this section, 15 per centum ad valorem.

None of the salts of lactic acid is provided for by name in the tariff act and all are therefore covered by paragraph 5, except the compounds of lactic acid and coal-tar derivatives, which would be dutiable under the tariff act of September 8, 1916.

DESCRIPTION AND USES.

Lactic acid, as its name implies, is the chief acid present in sour milk. It is not present in fresh milk, but is formed from the sugar in the milk during the fermentation or souring. It is also present in some other fermented food products, such as sauerkraut. Commercial supplies of lactic acid are not obtained, however, from milk, but by the regulated fermentation of some form of sugar, starch, or other carbohydrate material.

Technical lactic acid is customarily graded according to whether it is light or dark in color and according to its strength—22 per cent, 44 per cent, and 66 per cent being strengths commonly sold. These grades contain coloring matter and many impurities and usually have an unpleasant odor caused by the presence of some butyric acid. Lactic acid U. S. P. is a refined article containing not less than 85 per cent of lactic acid and conforming to the specifications of the Pharmacopœia, which insure that, except water, only traces of impurities shall be present.

"Edible" lactic is a refined acid which, however, does not conform to the strict specifications of the Pharmacopœia. It is usually weaker than the U. S. P. grade, has a yellowish color, and may contain small amounts of calcium sulphate. It should be free from butyric acid, which is always present in the technical acid, and which has an exceptionally unpleasant flavor.

The technical grades of lactic acid are used chiefly in tanning and dyeing. Hides are usually treated with lime, lime and sodium sulphide, or arsenic sulphide, to remove the hair. These materials are customarily removed from the hide by soaking in the "bran drench." The bran drench is prepared by the fermentation of a mixture of bran and water which yields an acid solution containing lactic, acetic, and butyric acids. Lactic acid or lactic acid mixed with sodium or potassium lactate is now being used by many tanners as a substitute for the bran drench. Lactic acid is used for "plumping" sole leather. Tanners now consume over half the lactic acid produced.

Lactic acid is also used in the dyeing of textiles and leather, especially in the chrome mordanting of wool and as a substitute for

acetic acid in dyeing and printing. It has the advantage of being much less volatile than acetic acid, and therefore is less liable to be lost in operations involving steaming or boiling. The antimony salt of lactic acid is a competitor of tartar emetic in dyeing, and titanium lactate is used in making leather.

Edible lactic acid has not been marketed extensively, but recent discoveries and commercial developments will probably cause it to be placed on the market in larger amounts and at a lower price. A large market will probably develop for beverages, and lactic acid may prove a serious rival to citric acid for these purposes. Another large prospective use is in the baking industry. It is claimed that the addition of lactic acid or a mixture of lactic acid and sodium lactate to the dough results in a marked improvement in the quality of the bread, especially when wheat substitutes are used. Lactic acid favors a more vigorous yeast fermentation in the dough, which is desirable, and inhibits the undesirable fermentations which sometimes result in the formation of "ropy" bread or "sour" bread. Lactic acid is also used to some extent in the brewing trade.

Lactic acid U. S. P. and several salts of lactic acid are also used in medicine. It is sometimes prescribed in cases of dyspepsia, diarrhea, croup, cholera carcinoma, and as a solvent for false membrane. Calcium lactate or calcium lacto-phosphate is occasionally prescribed as a cure for rickets and malnutrition of children. Some medical authorities claim that the habitual consumption of foods or beverages containing lactic acid acts as a preventive of intestinal diseases, such as typhoid fever and cholera.

PROCESS OF MANUFACTURE.

The manufacture of lactic acid may be considered as three steps: 1st, the preparation of the raw material in a condition suitable for the fermentation; 2d, the fermentation under conditions so regulated as to yield lactic acid primarily; 3d, the conversion of the product into a form suitable for sale and use.

Various raw materials are used. Glucose, made from cornstarch, gives a "light" product of good quality, but is more expensive than some other materials. Molasses from either cane or beet sugar was formerly the principal raw material, but is now in such great demand for food and for alcoholic fermentation that other cheaper materials are often used. Farinaceous materials, such as spoiled corn and potatoes, have been employed.

These require a preliminary treatment by boiling with acid in order to convert the starch into glucose, a variety of sugar.

Recently the waste obtained in the manufacture of buttons from vegetable ivory (tagua nuts) has become an important raw material for making lactic acid. This material must be heated with sulphuric acid under pressure to convert it into mannose (another variety of sugar) and the acid must then be neutralized. The sugar solution from any of these sources must be diluted to the proper strength, and some nitrogeneous plant food, such as corn meal, then added to nourish the microorganisms responsible for the fermentation.

Sugar is fermented by many different organisms yielding different products, such as alcohol, lactic acid, citric acid, butyric acid, glycerine, and acetone. The problem is, therefore, to control fermentation

in order to secure the maximum yield of lactic acid and the minimum of other products. This is accomplished not by sterilization of the materials and apparatus and subsequent inoculation with a pure culture of the desired ferment, but rather by controlling the temperature and acidity of the liquid. The lactic-acid ferment thrives at a temperature above that at which the other varieties of ferments are able to develop vigorously.

The fermentation process yields much heat; artificial heat is therefore not necessary except at the beginning of the fermentation or in very cold weather. The lactic acid produced tends to stop the process, and the acid must therefore be neutralized from time to time by the addition of lime. The fermentation requires about six or eight days and the product is a dilute solution containing calcium lactate, lactic acid, with some butyric and succinic acids, glycerine, coloring matter, and unchanged sugar.

In order to convert this material into a form suitable for sale, the lime must be eliminated by the addition of sulphuric acid. This converts the calcium lactate into lactic acid and calcium sulphate which is insoluble and can be separated by filtration. The resulting liquor is then evaporated in copper vessels, to the desired strength, usually 22 per cent or 44 per cent.

The manufacture of the edible and U. S. P. lactic acid is a more difficult and complex process, the details of which are guarded as trade secrets. The crude fermentation lactic acid is purified either (*a*) by crystallization of some salt (usually the calcium or zinc salt) and then by the separation of the free acid, or (*b*) by the distillation of the crude acid with superheated steam in a vacuum still, or (*c*) by the extraction with amyl alcohol or ether. The latter method is usually employed to make U. S. P. lactic acid.

The output of edible lactic acid in the past has been only a small percentage of the output of the technical acid. However, it is reported that manufacturers are planning to increase the production of the pure acid manyfold in the near future. There are at least four American companies with well-matured plans to enter this field.

HISTORY OF THE INDUSTRY.

The manufacture and chief uses of lactic acid were developed by Americans. The industry was well established in the United States before the manufacture of lactic acid was undertaken in foreign countries.

The founder of the industry was Charles E. Avery, who built the first lactic-acid factory in Littleton, Mass., in 1881. It had long been known that lactic acid is formed by the fermentation of starch and sugar and that the process always stopped after converting only a small fraction of the sugar into lactic acid. Avery found that the fermentation is stopped by the accumulation of the lactic acid itself and that if the acid is neutralized as formed, the fermentation may be continued until nearly all of the sugar is converted into salts of lactic acid.

Avery at first attempted to market the product in the form of an acid calcium lactate for use in baking powders as a substitute for cream of tartar. This attempt was, however, not successful, owing to difficulties in refining the lactic acid and to unsatisfactory keeping

qualities of the baking powder made therefrom. The product was then sold under the proprietary name of "Lactart" as an acid beverage. The original company, the Avery Lactate Co., discontinued manufacturing in 1887, and the plant was turned over to the bondholders, who continued the business under the name of the Avery Lactart Co. In 1894, A. A. Claflin, who was connected with the Avery Lactart Co., developed the use of lactic acid in the dyeing of wool with chrome mordants. A technical grade of acid which was comparatively easy to make was satisfactory for the purpose, and a rapid expansion of the industry followed the broadening of the market. Within a few years the manufacturers developed the use of lactic acid in tanning leather as a substitute for the bran drench and as a plumping agent. The tanning industry has since become the largest outlet for lactic acid. As a result of these discoveries the output increased from about 10,000 pounds in 1894 to about 400,000 pounds in 1897.

In 1895 the Avery Lactart Co. changed its name to the Avery Chemical Co. and established agencies in England, Belgium, and Germany to develop their export business.

The industry has since had a considerable growth in the United States. The output of technical lactic acid during 1917, calculated as 100 per cent lactic acid, exceeded 1,900,000 pounds, valued at approximately $340,000. This is nearly twice the output during 1915.

The following companies have made technical lactic acid during 1917 or 1918: American Alkali and Acid Co., Bradford, Pa.; Atlantic Chemical Co., Mansfield, Mass.; Avery Chemical Co., Lowell, Mass.; Harrison Works of Du Pont Co., Philadelphia, Pa.; West Chester Chemical Co., Pelham, N. Y.; and Woolner & Co., Peoria, Ill.

Edible lactic acid was put on the market during 1915 by the Avery Chemical Co.

In 1896 the first commercial lactic-acid factory outside the United States was erected by C. Boeringher & Sohn, of Nieder Ingelheim, Germany. The industry has since grown in Germany much more rapidly than in the United States. Although no figures on Germany's production are available the exports from Germany have been at least twice as great as the American production.

INTERNATIONAL TRADE.

The following tables from "Vierteljahrshefte zur Statistik des Deutschen Reichs" for 1914 show imports and exports from Germany:

TABLE I.—*Imports and exports of lactic acid and its salts for Germany, 1909–1913.*

Year.	Imports into Germany.		Exports from Germany.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1909	6,614	$476	2,300,941	$124,340
1910	42,108	2,332	2,817,479	152,210
1911	34,171	2,144	3,983,051	271,786
1912	111,773	6,670	3,923,747	293,462
1913	26,455	1,667	4,518,328	311,803

TABLE II.—*Exports of lactic acid and its salts from Germany, by principal countries, 1913.*

Exported to—	Quantity (pounds).	Value.
United Kingdom	1,681,755	$93,370
France	621,918	48,808
United States	449,738	46,214
Switzerland	233,908	11,434
Austria-Hungary	207,012	13,265
Russia	126,103	12,148
Japan	62,890	18,580
All others	1,132,504	76,222
Total	4,513,328	311,808

The principal raw material in Germany is potato starch which is produced in large quantities in the well-developed potato-product industry of eastern Germany and Poland. With the more intensive methods of cultivation and the liberal use of fertilizers, yields averaging about 300 bushels of potatoes to the acre are obtained. The Germans have developed a variety of potato, rich in starch and low in protein, which furnishes the raw material for important potato-starch, alcohol, and lactic-acid industries. Nevertheless the German industry does not have any advantage in raw materials over the American industry, which depends on corn and vegetable ivory waste for raw materials.

IMPORTS.

TABLE III.—*Imports of lactic acid for consumption in the United States, 1906–1919.*

Fiscal year	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1906	3 cents per pound	37,867	$6,480	$1,136	$0.17	17.53
1907	do	44,708	5,140	1,341	.11	26.09
1908	do	82,671	11,069	2,480	.13	22.41
1909	do	185,935	18,022	5,578	.10	30.95
1910 [1]	2 cents per pound when containing less than 40 per cent.	3,650	357	73	.10	20.45
1911	do	28,266	3,298	565	.12	17.14
1912	do	32,878	3,261	658	.10	20.16
1913	do	19,521	1,295	390	.07	30.15
1910 [1]	3 cents per pound when containing more than 40 per cent.	214,354	17,039	6,431	.08	37.74
1911	do	173,105	13,172	5,193	.08	39.42
1912	do	302,457	22,006	9,074	.07	41.24
1913	do	139,233	17,734	4,177	.13	23.55
1914 [2]	do	34,103	4,618	1,023	.14	22.15
1914 [3]	1½ cents per pound	242,134	25,605	3,632	.11	14.18
1915	do	143,291	26,787	2,149	.19	8.02
1916	do	17,845	10,930	268	.62	2.45
1917	do	100	160	2	1.60	.94
1918	do	330	544	5	1.65	.91
1919						
1919 (calendar year)	1½ cents per pound	11,023	3,927	165	.35	4.21

[1] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[2] Act of 1909, July 1, 1913, to Oct. 3, 1913.
[3] Act of 1913, Oct. 4, 1913, to June 30, 1914.

The import statistics are not directly comparable because they do not furnish definite information in regard to the strength of the acid.

In order to avoid the payment of freight and duties on water, the acid which is handled in international trade is generally stronger than that sold in the American markets.

It is clear from Tables I and II that in the period immediately preceding the war the German industry had considerably outgrown the American industry. German exports alone were more than twice the American production. Since the beginning of the war, the American industry has grown rapidly, the output having doubled in three years.

The United States export statistics do not give data on the exportation of lactic acid. Information received by the Tariff Commission shows that at least one American manufacturer was exporting lactic acid before the outbreak of the European war, although in amounts much smaller than the German exports. Since the outbreak of the European war the American exports have greatly increased.

A considerable increase in the American production of edible lactic acid is already evident. This product will probably prove a serious competitor to citric acid and tartaric acid in beverages and may even prove to be a competitor of vinegar in food products.

PRICES.

The prices of lactic acid vary widely according to the quality of the product. The following prices on technical lactic acid are given on the authority of Mr. A. A. Claflin, vice-president of the Avery Chemical Co. The prices are based on 100 per cent lactic acid.

	Per pound.		Per pound.
1895	$0.80–$1.00	1914	$0.09–$0.20
1897	.20– .60	1917	.16– .30
1900	.16– .30	1918	.25– .35
1905	.11– .24	1919	.25– .35
1910	.09– .20		

TARIFF HISTORY.

The rates of duty on lactic acid from 1883 to the present time are as follows:

Act of—		Tariff classification or description.	Rates of duty.
Year.	Paragraph.		
1883..	594	Acids used for medicinal, chemical, or manufacturing purposes, not specially provided for.	Free.
1890..	473	.....do.....	Do.
1894..	363	.....do.....	Do.
1897..	1	Lactic acid.....	3 cents per pound.
1909..	1	Lactic acid, containing not more than 40 per cent by weight of actual lactic acid.	2 cents per pound.
		Containing over 40 per cent by weight of actual lactic acid.....	3 cents per pound.
1913..	1	Lactic acid.....	1½ cents per pound.

TABLE IV.—*Rates of import duties on lactic acid in principal countries.*

[Compiled from official texts on file in Bureau of Foreign and Domestic Commerce, Department of Commerce, and corrected to Jan. 1, 1919.]

Countries.	Tariff No.	Foreign rate.	United States equivalents (dollars per pound)
United States	1		$0.015.
United Kingdom		Free	Free.
France:			
General tariff—[2]			
60 per cent or less [3]	238	22 francs per 100 kilos	$0.0193.
More than 60 per cent [4]	238	25 francs per 100 kilos	$0.0219.
Minimum tariff—			
60 per cent or less [3]	238	15 francs per 100 kilos	$0.0131.
More than 60 per cent [4]	238	18 francs per 100 kilos	$0.0158.
Germany	278	Free	Free.
Russia	112 (1)	3.96 roubles per pood	$0.0564.
Italy	37 (1)	25 lire per metric quintal	$0.0216.
Canada: [5]			
British preferential	216	20 per cent ad valorem	20 per cent ad valorem.
Intermediate	216	27½ per cent ad valorem	27½ per cent ad valorem.
General [3]	216	30 per cent ad valorem	30 per cent ad valorem.
Australia: [6]			
General [2]	281	5 per cent ad valorem	5 per cent ad valorem.
British preferential	281	Free	Free.
Japan	229	30 per cent ad valorem	30 per cent ad valorem.

[1] Conversions into United States currency are based on par value.
[2] The general rate is applied to the United States.
[3] Containing 60 per cent or less by weight of free acid.
[4] Containing more than 60 per cent by weight of free acid.
[5] All other acids n. c. s.
[6] Chemicals and drugs n. c. s.

TARIFF PROBLEM.

Under the tariff now in force there is a specific duty of 1½ cents per pound on lactic acid regardless of strength or purity. This duty bears very unevenly on the different commercial strengths and grades on the market. This difficulty might be overcome by the substitution of an ad valorem duty for the present specific duty or by imposing a different specific duty on the different strengths and grades of acid. Lactic acid suitable for edible and medicinal purposes should logically be made dutiable at a higher rate than the technical grade.

THE OXALIC-ACID INDUSTRY.

The tariff act of 1913 contains the following provisions:

Par. 1. * * * oxalic acid, 1½ cents per pound * * *.

No salts or compounds of oxalic acid are provided for by name and therefore such salts, known as oxalates, would be dutiable under paragraph 5, which reads:

Par. 5. Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof not specially provided for in this section, 15 per centum ad valorem.

DESCRIPTION AND USES.

Oxalic acid is an organic acid, found in many plants either in the free state or as the potassium or calcium salt. It derives its name from the plant *oxalis acetosella* (wood sorrel), which many years ago was cultivated as a source of oxalic acid. Oxalic acid is a white crystalline substance, containing water of crystallization and on reaction with metals it forms salts, known as oxalates, a few of which are of industrial importance.

The largest use of oxalic acid is as an acid rinse in commercial laundries. If the soap or alkali used in washing cotton clothing is not completely rinsed out, a slight yellow coloration is apt to be produced during ironing. This can be prevented by the neutralization of the alkali of the soap, by passing the washed and rinsed goods through a solution of some acid, and by a further rinsing to remove the acid. The several acids most commonly used for this purpose are oxalic acid, acetic acid, sulphuric acid, and niter cake (acid sodium sulphate). Sulphuric acid and niter cake are apt to damage the goods; they have only their relatively low cost to recommend them, and should never be used. Oxalic acid has an advantage over acetic acid in that it helps to remove iron stains. If used in small amounts and thoroughly rinsed out before ironing, it probably does little or no harm, but if these precautions are not adhered to the goods will be weakened. Since careless work by employees of laundries can not be entirely avoided, even with the best of intentions on the part of the proprietor, the use of oxalic acid is of questionable benefit to the public. Establishments laundering their own goods avoid the use of oxalic acid. Relatively few laundries in hotels, hospitals, textile mills, or homes use any oxalic acid at all. Acetic acid is commonly used in textile mills, and is replacing oxalic acid in many laundries. The use of any acid in the home is unusual. The only really essential use for oxalic acid in laundries is in cases where a special treatment is necessary to remove iron rust and ink stains.

Oxalic acid has important uses in dyeing and in printing textiles, especially in dyeing wool on a chrome mordant and in the manufacture of some dyes. Straw articles, especially straw hats, are bleached with oxalic acid, which is the essential ingredient in many proprietary hat-cleaning compounds. Oxalic acid is also used to some extent for the bleaching of leathers, wood and cork, shellac,

and as an ingredient in metal polishes. A blue ink is made by dissolving Prussian blue in oxalic acid. Chemical laboratories utilize oxalic acid as a reagent for many purposes.

There are a number of salts of oxalic acid which are of technical importance. Potassium acid oxalate (binoxalate), known as "salts of sorrel," is used for removing ink stains, for bleaching, scouring metals, and for cleansing wood. The ammonium, potassium, and sodium salts are important laboratory reagents. Cerium oxalate is used in medicine. Ferrous oxalate and ferric ammonium oxalate are used in photography, especially in making blue prints.

PROCESSES OF MANUFACTURE.

The history of the manufacture of oxalic acid is exceptionally interesting on account of the variety of methods that have been used, and because of the probability that radical changes in methods may be expected in the near future. In the early part of the nineteenth century oxalic acid and potassium oxalate were obtained from wood sorrel which was cultivated for this purpose. Although the use of the plant has been obsolete for a long time the salt is still sometimes called salt of sorrel. The next process was the oxidation of sugar or starch, by means of nitric acid, but this process has also become obsolete.

A process utilizing sawdust as raw material superseded these earlier methods and is still extensively used. Spruce sawdust is preferred, but other woods may be used. The sawdust is heated with alkalies to about 300° C. for 12 to 16 hours. The leading American producer asserts that caustic potash is essential for the purpose and that caustic soda, which is much cheaper than caustic potash and which resembles it in chemical properties, is not a satisfactory substitute. Potash is not present in the oxalic acid that is sold and should be recovered as completely as possible and reused. The profits depend very largely on reducing the losses of potash to a minimum. This repeated use of waste and mother liquors has necessitated a complex system which can not be described in detail.

During the heating of the sawdust with the caustic potash, considerable amounts of potassium oxalate are formed, but the product is very crude. It is cooled, dissolved in water, filtered, and the solution allowed to stand until the first crop of potassium oxalate has crystallized. The mother liquor is then concentrated by evaporation and a second crop of potassium oxalate is obtained in cooling. The second mother liquor is saved in order to recover the potash which it contains. The crystals of potassium oxalate are then treated with milk of lime, which causes the precipitation of insoluble calcium oxalate, and gives a solution of caustic potash that is concentrated by evaporation for reuse. The calcium oxalate is then filtered, washed, and treated with sulphuric acid, forming insoluble calcium sulphate and a solution of oxalic acid. The oxalic acid is recovered by concentration and evaporation. It is usually purified by one or two additional crystallizations. The commercial acid is sometimes slightly yellow in color, owing to the imperfect elimination of coloring matters derived from the wood, although in the better grades this color is so slight as to be noticeable only on very careful examination. Pure oxalic acid is a white crystalline substance.

A more recent process, which appears to be replacing the sawdust process in Europe, is known as the Goldschmidt or formate process. Carbon monoxide, under a pressure of about 10 atmospheres, is heated with caustic soda, with which it combines, yielding sodium formate. The sodium formate may then be heated further to about 400° C., a temperature which causes it to change into sodium oxalate and hydrogen gas. The sodium oxalate is then treated with milk of lime, yielding insoluble calcium oxalate and a solution of caustic soda, which may be used again for making more oxalate. The calcium oxalate is then converted into the acid by treatment with sulphuric acid.

Finally there is the possibility that oxalic acid may be made from sodium formate which is obtained from sodium cyanide. As has been explained more in detail in the chapter dealing with formic acid, there have recently been important advances in the manufacture of sodium cyanide which may make sodium cyanide much cheaper than it has been in the past. Sodium cyanide may be readily converted into sodium formate and ammonia and the former in turn into sodium oxalate and oxalic acid. Although this process has not yet been commercially developed there is a reasonable prospect that it may, during the next decade, prove to be a competitor of the older methods.

INTERNATIONAL TRADE.

At the beginning of the European War, the sawdust process was in operation in Germany, England, Norway, and the United States, and the formate process in Germany. Although no statistics of foreign production are available, it was a matter of common knowledge in the trade that Germany was the leading producer. Germany had an advantage in the sawdust process through control of potash and in the formate process on account of the original invention and development in that country.

TABLE I.—*Imports and exports of oxalic acid and potassium oxalate for Germany, 1900–1913.*[1]

Year.	Imports into Germany.		Exports from Germany.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1900	.....	.....	7,869,981	$407,932
1905	.....	.....	8,633,434	410,074
1909	3,748	$238	9,946,053	558,348
1910	33,951	1,666	9,445,609	479,332
1911	104,498	5,236	11,055,408	592,858
1912	13,889	714	10,477,362	594,286
1913	59,745	3,332	12,551,670	695,674

[1] From Vierteljahrshefte zur Statistik des Deutschen Reichs.

IMPORTS.

Imports of oxalic acid into the United States, in spite of a duty of 2 cents per pound under the act of 1909 and 1½ cents per pound under the act of 1913, considerably exceeded the American production.

TABLE II.—*Imports of oxalic acid for consumption into the United States, 1910–1919.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910[1]	Free	1,002,626	$61,271		$0.061	
1910[2]	2 cents per pound	4,832,553	279,714	$96,651	.058	34.55
1911	do	7,053,399	363,353	141,077	.051	38.83
1912	do	7,077,462	351,449	141,549	.049	40.28
1913	do	8,046,198	402,990	160,927	.050	39.94
1914[3]	do	1,617,682	79,567	32,353	.049	40.66
1914[4]	1½ cents per pound	7,163,170	354,216	107,447	.049	30.33
1915	do	4,496,879	282,422	67,450	.058	25.70
1916	do	522,549	166,117	7,838	.318	4.72
1917	do	1,183,156	527,837	17,749	.446	3.36
1918	do	757,553	311,290	11,363	.410	3.65
1919	do	456,098	154,041	6,850	.34	4.45
1919 (calendar year)	do	651,690	183,968	9,775	.282	5.31

[1] Act of 1897, July 1, 1909, to Aug. 5, 1909.
[2] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909, July 1, 1913, to Oct. 3, 1913.
[4] Act of 1913, Oct. 4, 1913, to July 30, 1914.

TABLE III.—*Imports of oxalic acid into the United States by countries, 1913–1918.*

Imported from—	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Germany	6,020,121	$295,052	6,668,291	$326,562	3,504,277	$201,599
Norway	1,386,945	71,798	777,566	38,561	472,949	23,447
United Kingdom	668,065	35,570	905,153	46,625	403,625	33,934
Netherlands			27,723	1,348	63,190	3,743
France					34,621	1,763
Denmark			11,012	555	13,128	1,197
Switzerland			22,416	1,066	10,003	875
Canada			38,384	2,621	9,744	1,094
Belgium	30,943	4,404	57,263	3,107	9,453	526
Austria					4,687	227
Mexico			22	2		
All other			20	2		
Total	8,136,074	406,824	8,507,850	420,409	4,525,677	268,407

Imported from—	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Germany	80,185	$5,676				
Norway	354,565	113,476	465,743	$225,284		
United Kingdom	6,755	2,027	75,652	34,920	601,499	$240,467
Netherlands	44,547	29,638	388,381	201,287	190,346	81,273
France						
Denmark						
Switzerland						
Canada	33,381	12,398				
Belgium						
Austria						
All other	6,614	3,667	154,767	55,138	538	45
Total	526,047	166,882	1,084,543	516,629	792,383	321,785

PRICES.

The outbreak of the European war resulted in a great decrease in imports and a great increase in price. The price in the United States for many years before the war varied from about 7 to 8½ cents per pound. By the beginning of 1915 it had risen to 20 cents, and

by the middle of 1916 to 80 cents; it has since dropped to about 25 cents. This rise in the price is doubtless in large part the result of the great increase in the cost of potash, which is used in the manufacture of oxalic acid.

TABLE IV.—*Wholesale prices of oxalic acid at New York, 1908–1919.*[1]

[Cents per pound.]

On or about—	1908	1909	1910	1911	1912	1913
Jan. 1	7 –7½	6.4–7	7½ –7¾	7½ –7¾	7.3–7½	7.1–7½
Apr. 1	6½–7	6.4–6.6	7½ –7¾	7½ –7¾	7.4–7.8	8 –8.1
July 1	6½	6.1–6½	7.2–8	7.1–8¼	8.1–8½	7.8–8
Oct. 1	6½–7	7½ –8	7½ –8	7.1–7.7	8 –8¼	7½ –8

On or about—	1914	1915	1916	1917	1918	1919
Jan. 1	7.1–7½	13–14	50–51	47 –57	45–46	36–46
Apr. 1	7.4–7½	18–18.5	70–80	44 –46	45–46	30–32
July 1	7½ –7¾	25–26	61–65	46.5–47	42–44	23–25
Oct. 1	16 –20	41–42	60–62	46 –49	41–42	23–26

[1] Source: Oil, Paint, and Drug Reporter.

TABLE V.—*Comparison of wholesale prices of oxalic acid in the United Kingdom and in the United States, by quarters, 1913–1918.*[1]

Years—Quarters.	Actual prices.		Relative prices.	
	United Kingdom.	United States.	United Kingdom.	United States.
Market	Manchester.	New York.		
Unit	Pound.	Pound.		
	£ s. d.	*Dollars.*		
Base price[2]	0 0 2.88	0.0751	100	100
1913.				
First	0 0 2.88	.0788	102	105
Second	0 0 2.92	.0791	103	105
Third	0 0 2.88	.0786	102	105
Fourth	0 0 2.88	.0750	102	100
1914.				
First	0 0 2.79	.0734	99	98
Second	0 0 2.75	.0734	97	98
Third	0 0 5.08	.1150	180	153
Fourth	0 0 7.92	.1433	280	190
1915.				
First	0 0 9.25	.1367	327	182
Second	0 0 11.33	.1900	400	253
Third	0 0 11.83	.3547	418	468
Fourth	0 1 1.67	.4700	483	626
1916.				
First	0 1 4.67	.5733	589	763
Second	0 1 9.00	.7117	742	948
Third	0 1 8.00	.6067	707	808
Fourth	0 1 6.67	.5733	660	763
1917.				
First	0 1 6.58	.4567	657	608
Second	0 1 6.00	.4567	636	608
Third	0 1 6.00	.4617	636	615
Fourth	0 1 6.00	.4567	636	608
1918.				
First	0 1 5.83	.4217	630	562
Second	0 1 5.50	.4367	618	582
Third	0 1 5.33	.4167	612	555
Fourth	0 1 4.75	.3967	592	528

[1] Source: International Price Comparisons, Department of Commerce, Washington, 1919.
[2] Average actual price from July, 1913, to June, 1914.

THE INDUSTRY IN THE UNITED STATES.

As a consequence of these changes in competitive conditions, there has been great activity in experimental work and in the industrial development of the oxalic-acid industry in the United States. A number of firms are just beginning commercial production (1919), and marked changes in competitive conditions may be expected in the future.

Before the outbreak of the European war, only one firm in the United States made oxalic acid—the American Alkali and Acid Co., of Bradford, Pa., who used the sawdust process. The caustic potash used was a high-grade product, made in Niagara Falls from muriate of potash imported from Germany. The curtailment of supplies of potash from Germany has forced the company to use a much cruder product, obtained from wood ashes, and to pay a price greatly in excess of the prewar prices for this material. During 1918, the replacement of the potash lost during the process has been the largest item of expense. When the imports from Germany were cut off by the war, this company became the chief source of supply for the American markets.

The Victor Chemical Co. of Chicago constructed a small experimental plant for the manufacture of oxalic acid by the formate process in 1915 and built a commercial plant during the latter part of 1916 and the early part of 1917. It has been producing oxalic acid in steadily increasing amounts since that time.

The Solvay Process Co. is endeavoring to solve the technical problems involved in substituting caustic soda for caustic potash in the sawdust process. If this could be done successfully it should cause a marked decrease in costs and therefore make the modified sawdust method a strong competitor in the industry. Although oxalic acid was produced in commercial quantities in 1917 and 1918 by this company the results obtained were not promising enough to justify the diversion of men and materials needed for war purposes and the attempt has therefore been abandoned, temporarily at least.

The United States Industrial Chemical Co. of New York has been experimenting, on a semicommercial scale, on a process for obtaining oxalic acid from a waste product which they secure in considerable amounts in making alcohol from molasses. They hope to develop this process commercially when the pressure of war work no longer puts obstacles in the way of new projects. These companies have had technical troubles and disappointments commonly met with in new industries.

TARIFF HISTORY.

Act of—		Tariff classification or description.	Rates of duty.
Year.	Paragraph.		
1890..	473	(Not specially provided for.) Acids for medicinal, chemical, and manufacturing purposes.	Free.
1894..	363	....do....	Do.
1897..	464	Oxalic acid....	Do.
1909..	1	....do....	2 cents per pound.
1913..	1	....do....	1½ cents per pound.

TABLE VI.—*Rates of import duties on oxalic acid in principal countries.*

[Compiled from official texts on file in Bureau of Foreign and Domestic Commerce, Department of Commerce, and corrected to Jan. 1, 1919.]

Countries.	Tariff No.	Foreign rate.	U. S. equivalents [1] (dollars per pound).
United States	1		$0.015.
United Kingdom		Free.	Free.
France:			
General tariff [2]	238ex	19 francs per 100 kilos	$0.0166.
Minimum tariff	238ex	12.50 francs per 100 kilos	$0.0109.
Germany: General tariff	276ex	8 marks per 100 kilos	$0.0086.
Russia	112(1)	3.60 roubles plus 10 per cent per pood.	$0.0564.
Italy:			
General tariff	37(o)	10 lire per metric quintal	$0.0087.
Conventional tariff	37(o)	.....do	$0.0087.
Canada:			
British preferential	208ex	5 per cent ad valorem	5 per cent ad valorem.
Intermediate	208ex	7½ per cent ad valorem	7½ per cent ad valorem.
General [2]	208ex	.....do	Do.
Australia: [3]			
British preferential	281	Free	Free.
General tariff [2]	281	5 per cent ad valorem	5 per cent ad valorem.
Japan:			
General tariff [2]	155	2.00 yen per 100 kin	$0.0074.

[1] Conversions into United States currency are based on par value.
[2] The general rate is applied to the United States.
[3] Chemicals, n. o. s.

TARIFF PROBLEM.

One of the oxalic-acid manufacturers in the United States uses a process which requires caustic potash and is therefore affected by the rate of duty on potash salts. The other manufacturers do not use potash. Reference should be made to the chapter on formic acid for a discussion of the influence which a duty on sodium formate may have on the oxalic-acid industry.

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THE TARTARIC-ACID AND CREAM OF TARTAR INDUSTRY.

The tariff act of 1913 contains the following provisions:

Par. 1. * * * tartaric acid, 3½ cents per pound; * * *.

Par. 5. Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof not specially provided for in this section, 15 per centum ad valorem.

Par. 8. Argols or crude tartar or wine lees crude or partly refined, containing not more than 90 per centum of potassium bitartrate, 5 per centum ad valorem; containing more than 90 per centum of potassium bitartrate, cream of tartar, and Rochelle salts or tartrate of soda and potassa, 2½ cents per pound; calcium tartrate crude, 5 per centum ad valorem.

DESCRIPTION.

Argols, wine lees, crude tartar, and crude calcium tartrate are raw materials from which tartaric acid, cream of tartar, and Rochelle salts are prepared. A few other salts of tartaric acid, such as tartar emetic, which are not specially mentioned in the tariff act but are dutiable under paragraph 5, are prepared from the same raw materials.

Although tartaric acid and its salts occur in nature in many plants and fruits, commercial supplies are obtained exclusively as a by-product of the wine industry, mainly from fortified wines.

Wine lees are a deposit or sediment which collects in the bottom of wine casks during the fermentation of the wine. The valuable ingredients are potassium acid tartrate and calcium tartrate. They contain also yeast cells, proteins, and other solid matter which was suspended in the grape juice. Wine lees vary enormously in quality, but usually contain from 20 to 35 per cent of potassium acid tartrate and up to 20 per cent of calcium tartrate.

Argols are a crystalline deposit which forms on the sides of wine casks during fermentation. Argols are similar to wine lees in their chemical nature, but are purer than wine lees, since they contain less sediment. They contain from about 50 to 85 per cent (rarely up to 88 per cent) of potassium acid tartrate, and 6 to 12 per cent of calcium tartrate.

Crude tartar is made by the purification of wine lees or argols, or may be the same as argols. It consists essentially of potassium acid tartrate, but is not sufficiently pure to be known as cream of tartar. Under the tariff act of 1913 crude tartar containing not more than 90 per cent of potassium bitartrate is dutiable at a lower rate than that containing more than 90 per cent of potassium bitartrate.

Tartaric acid appears in commerce as colorless transparent crystals or in a granular form or as a white powder. It is readily soluble in water and has a pleasant acid taste. Grapes and some other fruits contain tartaric acid. It forms salts with the metals which are known as tartrates, and are of two series—acid salts in which the acid is only half neutralized and neutral salts in which the acid is completely neutralized.

Cream of tartar is refined potassium acid tartrate (potassium bitartrate) and if intended for use in drugs or baking powder should conform to the specifications of the Pharmacopoeia which require at least 99.5 per cent of potassium bitartrate. The better grades on the market contain less than 5 parts per million of lead or other heavy metals.

Rochelle salt (also called Seignette salt) is a trade name for sodium potassium tartrate (or tartrate of soda and potassa).

Calcium tartrate is important only as a raw material from which cream of tartar or tartaric acid can be made.

Tartar emetic is the double tartrate of potassium and antimony. It is probably the most important of the salts of tartaric acid not specially provided for in the tariff act.

USES.

The most important use of any of these tartar products is the use of cream of tartar and tartaric acid in one variety of baking powder. The tartrate baking powders consist essentially of a mixture of cream of tartar, tartaric acid, bicarbonate of soda, and starch. When moistened with water the mixture evolves carbon-dioxide gas which produces the desired leavening effect. This is greatly accelerated by the action of heat during baking. Baking powder finds an extensive use in the United States for making bread, cakes, and biscuits. It is primarily an American product, invented and commercially developed in the United States, and more generally used in the United States than in any other nation. There are other kinds of baking powders on the market in which the cream of tartar is replaced by alum or calcium acid phosphate or both. A considerable export business in baking powders has been developed by American manufacturers. The per capita consumption in Australia and Canada approaches that of the United States, but the per capita consumption in Europe is considerably less than that of the United States.

Cream of tartar, crude tartar, and tartaric acid are used as mordanting assistants for dyeing wool with a chrome mordant and in printing textiles. Tartrates also find some use in photographic developing and printing. Another technical application is for depositing a thin layer of silver on glass for mirrors or ornaments. Minor uses of cream of tartar and tartaric acid are in the manufacture of tartar emetic, Rochelle salt and other pharmaceutical preparations; food products, especially jellies, preserves, and beverages; and as a laboratory reagent. In Europe considerable quantities of tartaric acid are added to low-acid wines.

Tartar emetic, a double tartrate of potassium and antimony, is used in medicine to produce vomiting. In the dyeing of textiles (usually in connection with the tannin) it serves to deposit antimony on the fiber as a mordant.

Dioxytartaric acid is used in the manufacture of the important dye, tartrazine.

Rochelle salt is used in medicine and photography, and in the chemical laboratory as an important reagent for the analytical determination of starch and sugars.

PROCESS OF MANUFACTURE.

In the United States the relatively large development of the baking-powder industry has caused the demand for cream of tartar to exceed the demand for tartaric acid, and therefore, as a rule, the process is operated to secure the maximum yield of cream of tartar. In recent years, however, there has been an increase in the use of tartaric acid in pharmaceutical products which has made it advisable in some plants to modify the process so as to secure a slightly larger proportion of tartaric acid. On the whole tartaric acid is less important and is usually regarded as a by-product.

(*a*) *Cream of tartar.*—The process of preparing cream of tartar from argols or wine lees is fundamentally a process of purification by solution, filtration, and recrystallization with the utilization of mother liquors and wash waters as a source of the by-product, tartaric acid. As cream of tartar is only sparingly soluble, the process requires the handling of large volumes of dilute solutions. On account of its use in baking powder and foods, the product must be refined to a high grade of purity, and especial care must be taken to insure the absence of lead or other heavy metals.

The following brief synopsis of the process of manufacture applies to material containing relatively little calcium tartrate. The argols or wine lees are first ground and then dissolved by heat in a mother liquor obtained from a previous lot at a later stage in the refining process. These mother liquors are used instead of pure water in order to avoid the loss of the valuable tartar material which they contain. The hot solution is allowed to settle and is decanted from the insoluble residue, which is used later in the manufacture of tartaric acid. After the solution stands until cold there is a deposition of crystals of impure brown potassium acid tartrate. Part of the mother liquor is returned to dissolve a fresh lot, and part is utilized as a source of tartaric acid. Removal of a part of the mother liquor is essential to avoid the accumulation of impurities in the system.

The deposited brown crystals are washed, redissolved in a mother liquor from a later part of the process, and the solution is decolorized by bone charcoal, filtered, and crystallized by cooling. If the crystals are sufficiently pure for the purpose for which they are intended it remains only to dry the product. If not sufficiently pure, another solution and crystallization may be necessary. The mother liquors of the last crystallization are used for the recrystallization of the next lot of brown crystals.

(*b*) *Tartaric acid.*—Tartaric acid may be made either as a by-product of the cream of tartar manufacture (from the residues and mother liquors of the process described above) or as the primary product from crude tartar materials rich in calcium tartrate.

The first step is to add lime to neutralize the free acid and then add precipitated calcium sulphate (from a later stage of the process). This converts all of the tartaric acid present into insoluble calcium tartrate. The calcium tartrate is then repeatedly washed with water until cleansed of all soluble impurities and much of the solid impurities which are of such flocculent character that they may be floated away from the denser calcium tartrate. Dilute sulphuric acid is then added and the whole stirred until the decomposition of the calcium

tartrate is complete. This yields a solution of tartaric acid with excess of sulphuric acid and insoluble calcium sulphate mixed with some solid impurities from the original raw materials. The solution is then filtered from the solid matter, evaporated (usually in lead pans) until concentrated sufficiently to yield the crystals of tartaric acid upon cooling.

The product at this stage is brown in color owing to the presence of impurities. The crystals are redissolved, decolorized by means of bone black, filtered, concentrated by evaporation, and recrystallized by cooling. The tartaric acid obtained is white in color but will contain traces of lead if lead vessels were used in any of the foregoing operations. If the product is intended to be used for drug or food purposes the lead must be removed, which is usually accomplished by passing hydrogen-sulphide gas through the solution of the acid followed by another crystallization. This operation must be done in porcelain or earthenware apparatus.

Although considerable work has been done by American chemists on synthetic processes for the production of tartaric acid, the work has not yet passed the experimental stage.

INTERNATIONAL TRADE IN CRUDE TARTAR MATERIALS.

SOURCE OF TARTAR RAW MATERIALS.

As the raw materials for making cream of tartar and tartaric acid are exclusively by-products of the wine industry, the output is dependent on the wine production and is not appreciably affected by the demand for argols. Although no reliable statistics of production are available, Italy and France are undoubtedly the chief source of materials and together probably produce more than three-fifths of the total world's supply. Spain, Portugal, and French Africa are also important producers, while Austria-Hungary and Germany are minor sources of supply. In recent years Argentina has become a producer of argols. Production in the United States is small, probably less than 1 per cent of the world's supply. When the Constitutional amendment prohibiting the manufacture of alcoholic beverages goes into effect, the production of tartar raw materials in the United States will be almost entirely stopped.

A small yield of argols is obtained from the unfermented grape-juice industry, but the amount from this source will remain relatively small, since potassium bitartrate is much less soluble in alcohol than in water and is mainly deposited as a result of the formation of alcohol during fermentation. Comparatively little is deposited from unfermented juice.

The world's commerce in the raw materials of the tartar industry is shown in the following tables of imports and exports from the principal producing and consuming countries.

ITALY.

The Italian exports of crude tartar are somewhat greater than those of France, and before the war the United States and the United Kingdom accounted for approximately two-thirds of the total. Italy also leads in the exports of wine lees, which are consumed mostly in Germany and the Netherlands.

EXPORTS FROM ITALY.

TABLE I.—*Exports of crude tartar and wine lees from Italy, 1910–1917.*[1]

Year.	Crude tartar.		Crude wine lees.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1910	22,660,043	$1,785,427	16,697,640	$438,534
1911	17,737,091	1,552,859	12,174,242	383,682
1912	18,946,963	1,725,048	13,600,177	428,622
1913	18,286,275	1,680,900	9,400,194	304,485
1914	21,965,753	2,499,867	11,680,411	388,569
1915	17,405,506	2,865,763	5,270,096	239,911
1916	10,295,702	2,208,257	88,625	5,431
1917	14,755,908	3,164,832	971,788	59,552

[1] From Movimento Commerciale del regno d'Italia.

TABLE II.—*Exports of crude tartar and wine lees from Italy, by countries, 1913.*[1]

Exported to—	Crude tartar.		Crude wine lees.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Netherlands	777,122	$71,434	3,100,108	$100,417
Germany	2,307,775	212,134	4,308,009	139,542
United States	8,772,103	806,344	696,874	22,573
Austria-Hungary	1,042,114	95,763	199,296	6,455
United Kingdom	3,714,090	341,404	548,725	17,774
France	387,128	35,585	.....	.....
Switzerland	252,427	23,203	.....	.....
All other	1,033,516	95,003	547,182	17,724
Total	18,286,275	1,680,900	9,400,194	304,485

[1] From Movimento Commerciale del regno d'Italia.

The Italian exports of crude tartar and crude wine lees are much greater than exports of the refined cream of tartar and tartaric acid. Italy also imports very small amounts of crude tartar and wine lees, chiefly from Austria Hungary, Tunis, Greece, and Turkey.

FRANCE.

France is the most important marketing place in the world for tartar materials, and developments in that country since 1914 have affected the entire cream of tartar industry. The crude materials from France and Algeria, as well as a large proportion of the Italian and Spanish production, have always been sold in the French markets to French, American, and German refiners. Small purchases were made by the English, but for the most part England was supplied with the refined product from France. With the declaration of war the German buyers disappeared from the market, and a somewhat sharper competition arose between the French and American interests.

The French refiners desired to obtain more complete control of the markets and stimulated the Government to take measures for checking the exports of the crude materials. Under its very broad war powers, the French Government in October, 1914, prohibited all exports of tartar raw materials. Through the efforts of an association of wine growers and of various chambers of commerce in the wine-growing region, the Government was induced to modify its policy,

TABLE VII.—*Imports for consumption of argols, partly refined, or tartars and lees crystals, containing not more than 90 per cent of potassium bitartrate.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Actual and computed ad valorem rate.
		Pounds.			*Per cent.*
1910	3 cents per pound	34,710	$3,893	$1,041	26.72
1911	do	8,926	1,168	267	22.93
1912	do	14,502	1,875	435	23.20
1913	do	5,498	763	164	21.62

TABLE VIII.—*Imports of argols or crude tartar or wine lees, crude or partly refined, containing more than 90 per cent of potassium bitartrate.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Actual and computed ad valorem rate.
		Pounds.			*Per cent.*
1911	4 cents per pound	9,921	$1,962	$397	20.23
1912					
1913					
1914	2½ cents per pound	1,162	229	29	12.69
1915	do	79	9	2	22.00
1916	do				
1917	do	24,409	6,322	610	9.65
1918	do	44,333	5,490	1,108	20.18
1919	do	9,045	1,250	226	18.08
1919 (calendar year)	do	50,462	14,773	1,261	8.54

TABLE IX.—*Imports of crude calcium tartrate for consumption.*

Fiscal years.	Rates of duty.	Quantity.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
	Per cent.	*Pounds.*				*Per cent.*
1914	5	118,256	$8,849	$442	$0.0748	5
1915	5	1,755,974	161,556	8,077	.0920	5
1916	5	1,101,255	135,638	6,781	.1231	5
1917	5	371,910	51,418	2,571	.1382	5
1918	5	118,355	19,715	986	.1666	5
1919						

INTERNATIONAL TRADE IN REFINED CREAM OF TARTAR AND TARTARIC ACID.

The manufacture of cream of tartar and tartaric acid is carried on to a considerable extent in Italy, France, and Spain near the source of the raw materials. England, Germany, Russia, and the United States have factories for making the refined articles from imported raw materials.

The relative importance of tartaric acid and cream of tartar differs in Europe and the United States. Baking powders containing cream of tartar are more generally used in the United States than in Europe. On the other hand, there is a considerable market in Europe for tartaric acid as an addition to grape juice to be used for wine making.

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ITALY.

Italy's exports of tartaric acid varied from about five million to eight million pounds per year from 1910 to 1915 and the United Kingdom and Argentina were her best customers. Until 1913, however, imports of cream of tartar into Italy exceeded exports therefrom, but since that date exports have been greater than imports and have gone chiefly to England.

TABLE X.—*Imports and exports of tartaric acid for Italy, 1910–1917.*[1]

Fiscal year.	Imports into Italy.		Exports from Italy.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	656,089	$134,977	4,800,296	$997,210
1911	442,683	106,574	5,545,450	1,335,049
1912	322,532	80,480	5,546,994	1,383,981
1913	88,845	22,167	6,274,733	1,565,552
1914	44,753	11,166	6,531,789	1,715,461
1915	192,462	101,093	8,012,398	4,208,635
1916	57,549	42,817	7,257,984	5,400,854
1917	1,543	1,148	5,319,038	3,958,034

[1] From Movimento Commerciale del regno d'Italia.

TABLE XI.—*Imports and exports of cream of tartar for Italy, 1910–1917.*[1]

Fiscal year.	Imports into Italy.		Exports from Italy.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
1910	138,449	$18,180	71,429	$9,380
1911	356,043	56,105	54,013	8,511
1912	261,907	42,646	58,201	9,477
1913	74,296	11,739	767,201	124,925
1914	732,589	153,921	1,322,760	277,920
1915	230,381	83,699	3,208,795	1,165,783
1916	38,801	16,984	2,150,587	941,358
1917	2,425	1,062	1,607,594	703,678

[1] From Movimento Commerciale del regno d'Italia.

TABLE XII.—*Exports of tartaric acid and cream of tartar from Italy, by countries, 1913.*[1]

Exports to—	Tartaric acid.		Cream of tartar.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
Austria-Hungary	223,546	$55,775	40,124	$6,533
France	429,015	107,040	.....	.....
Germany	316,360	78,932	44,092	7,180
United Kingdom	1,933,699	494,935	601,415	97,930
Switzerland	261,025	65,126	.....	.....
Turkey in Europe	127,426	31,793	.....	.....
Australia	58,422	14,576	31,305	5,098
Argentina	1,687,401	421,008	.....	.....
United States	62,611	15,621	.....	.....
Brazil	.....	.....	6,398	1,041
Spain	.....	.....	24,030	3,912
Other countries	1,125,228	280,746	19,842	3,231
Total	6,274,733	1,565,552	767,201	124,925

[1] From Movimento Commerciale del regno d'Italia.

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FRANCE.

France is also an important exporter of cream of tartar and tartaric acid. French cream of tartar goes almost entirely to Great Britain and Australia. French tartaric acid is much more widely distributed than the cream of tartar. Algeria has taken more French tartaric acid than any other nation, and England, Argentina, and Germany have also been good customers for tartaric acid.

TABLE XIII.—*Exports of tartaric acid and cream of tartar from France, 1910–1918.*[1]

Fiscal year.	Tartaric acid.		Cream of tartar.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1910	2,398,825	$546,009	11,300,780	$2,127,034
1911	2,398,604	596,454	10,678,201	1,682,667
1912	2,432,776	564,385	10,992,797	1,732,241
1913	2,677,707	644,649	8,745,207	1,607,744
1914	2,129,644	540,670	6,943,167	1,276,452
1915	2,264,345	825,075	7,072,357	1,671,766
1916	2,014,784	1,428,779	5,000,915	1,182,125
1917	1,554,904	1,268,010	3,900,599	1,383,038
1918	1,220,026	994,336	3,235,471	1,147,192

[1] From Documents Statistiques sur le Commerce de la France.

TABLE XIV.—*Exports of tartaric acid and cream of tartar from France, by countries, 1913.*[1]

Exported to—	Tartaric acid.		Cream of tartar.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Great Britain	73,634	.....	4,174,190	.....
Germany	223,987	.....	443,345	.....
Belgium	36,596	.....	200,178	.....
Italy	65,036	.....	.....	.....
Turkey	182,100	.....	.....	.....
Switzerland	587,526	.....	.....	.....
Argentina	337,304	.....	.....	.....
Spain	208,555	.....	.....	.....
United States	40,785	.....	.....	.....
Australia	135,582	.....	3,651,258	.....
Colonies:				
Algeria	376,546	.....	.....	.....
Other colonies	56,658	.....	.....	.....
All other countries	353,398	.....	276,236	.....
	2,677,707	$644,649	8,745,207	$1,607,744

[1] From Documents Statistiques sur le Commerce de la France.

GERMANY.

Germany did an export business in these refined products comparable in magnitude with the exports of France and Italy, although the German industry was largely dependent on imported raw materials.

TABLE XV.—*Imports and exports of crude and refined tartar for Germany, 1909–1913.*[1]

Fiscal year.	Imports into Germany.		Exports from Germany.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1909	4,467,181	$368,900	2,533,967	$410,312
1910	6,760,406	578,102	3,937,195	679,966
1911	7,071,695	658,784	4,453,292	800,582
1912	9,387,628	875,126	4,881,205	891,072
1913	13,911,687	1,436,806	7,392,685	1,326,374

[1] From Vierteljahrshefte zur Statistik Des Deutschen Reichs.

TABLE XVI.—*Imports and exports of tartartic acid for Germany, 1909–1913.*[1]

Fiscal year.	Imports into Germany.		Exports from Germany.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1909	714,511	$142,800	5,086,012	$1,015,784
1910	1,009,927	207,060	4,643,769	952,476
1911	834,882	207,298	4,079,392	1,030,778
1912	942,687	233,954	5,913,178	1,468,936
1913	716,715	178,024	6,514,813	1,714,076

[1] From Vierteljahrshefte zur Statistik Des Deutschen Reichs.

THE INDUSTRY IN THE UNITED STATES.

IMPORTS.

Under the tariff act of 1909 the rates of duty on crude tartar materials and on cream of tartar and tartaric acids were so adjusted as to be almost prohibitory on the refined articles. The tariff act of 1913, which lowered the rates on the refined articles, was followed by an increase in the imports of cream of tartar and tartaric acid during the 1914 and 1915 fiscal years, but imports of the crude materials continued to be equivalent to more than five times those of the refined articles. (See Tables V–IX for the imports of the crude materials.)

IMPORTS INTO THE UNITED STATES.

TABLE XVII.—*Imports of tartar, cream of tartar, and patent tartar for consumption in the United States, 1910–1919.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910[1]	5 cents per pound	116,187	$9,889	$5,809	$0.0851	58.75
1911	do	23,433	3,401	1,171	.1451	34.45
1912	do	82,980	16,300	4,149	.1964	25.45
1913	do	66,718	11,797	3,335	.1768	28.28
1914[2]	do	436	100	21	.2316	21.58
1914[3]	2½ cents per pound	812,421	156,886	20,310	.1931	12.95
1915	do	764,868	166,922	19,121	.2182	11.46
1916	do	38,588	13,479	964	.3493	7.16
1917	do	98,609	28,488	2,465	.2888	8.65
1918	do	68,586	16,067	1,715	.2342	10.67
1919 (calendar year)		23,652	10,879	591	.460	5.44

[1] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[2] Act of 1909, July 1 to Oct. 3, 1913.
[3] Act of 1913, Oct. 4, 1913, to June 30, 1914.

TABLE XVIII.—*Imports of tartaric acid for consumption in the United States, 1909–1919.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	7 cents per pound	124,774	$23,245	$8,734	$0.1862	37.57
1910[1]	do	16,249	2,854	1,137	.1756	39.85
1910[2]	5 cents per pound	88,208	15,744	4,410	.1784	28.01
1911	do	331,538	72,204	16,576	.2177	22.96
1912	do	105,311	24,116	5,265	.2289	21.83
1913	do	78,942	15,747	3,947	.1994	25.07
1914[3]	do	22,076	4,932	1,103	.2234	22.38
1914[4]	3½ cents per pound	826,499	198,918	28,927	.2407	14.54
1915	do	820,105	273,880	28,703	.3339	10.48
1916	do	198,873	84,373	6,960	.4242	8.25
1917	do	268,180	162,478	9,386	.6058	5.78
1918	do	384,262	231,099	13,449	.6014	5.81
1919	do	321,256	218,441	11,244	.68	5.15
1919 (calendar year)	do	654,736	447,571	22,916	.698	5.12

[1] Act of 1897, July 1 to Aug. 5, 1909.
[2] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909, July 1 to Oct. 3, 1913.
[4] Act of 1913, Oct. 4, 1913, to June 30, 1914.

The source of the tartaric acid imported during the fiscal year ending June 30, 1914, was as follows: Germany 39.6 per cent, England 19.8 per cent, Italy 10.3 per cent, Austria-Hungary 9.1 per cent, Netherlands 8 per cent, and France 7.2 per cent

TABLE XIX.—*Imports of tartrate of soda or potassa or Rochelle salts for consumption in the United States, 1909–1919.*

Fiscal year.	Rates of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	4 cents per pound	40,123	$4,913	$1,604	$0.1224	32.67
1910[1]	do	2,332	269	93	.1153	34.68
1910[2]	3 cents per pound	35,544	4,059	1,066	.1141	26.27
1911	do	78,257	9,035	2,347	.1154	25.98
1912	do	86,447	11,270	2,593	.1303	23.01
1913	do	138,115	16,927	4,143	.1225	24.48
1914[3]	do	39,207	4,813	1,176	.1227	24.44
1914[4]	2½ cents per pound	147,098	18,606	3,677	.1264	19.76
1915	do	253,609	19,244	6,340	.0758	32.95
1916	do	187	47	4	.2513	9.96
1917	do	17,840	4,352	446	.2439	10.25
1918	do	31,160	8,614	779	.2764	9.04
1919	do	6,742	2,966	169	.44	5.66
1919 (calendar year)	do	29,142	9,537	728	.327	7.64

[1] Act of 1897, July 1 to Aug. 5, 1909.
[2] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909, July 1 to Oct. 3, 1913.
[4] Act of 1913, Oct. 4, 1913, to June 30, 1914.

EXPORTS.

Exports of tartar and tartaric acid are not shown separately in the available statistics of the United States, but it is believed that exports of these materials until the outbreak of the European War have been small. Exports in the form of baking powder have, however, been large, as is shown in Table XX.

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TABLE XX.—*Domestic exports of baking powder from the United States, 1911–1918.*

Exported to—	1911		1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
England	134,350	$34,627	164,286	$40,783	204,506	$49,993	228,919	$48,998
Scotland	141,146	46,228	138,640	46,331	152,678	50,834	208,924	52,153
Ireland	187,943	43,931	247,222	51,523	192,923	45,502	181,250	41,117
Canada	232,879	78,931	479,465	151,210	643,199	189,575	537,551	161,241
Panama	53,813	15,360	63,812	17,214	72,865	20,553	70,131	19,663
Mexico	202,453	54,999	222,368	58,797	242,765	69,834	68,291	19,387
Newfoundland and Labrador	69,002	15,924	74,661	17,329	73,149	16,854	87,174	18,471
Cuba	26,357	7,148	26,461	7,740	34,050	10,534	42,873	12,714
South America:								
Argentine	80,644	27,843	82,598	29,531	82,602	28,960	115,791	40,819
Brazil	19,837	5,763	29,182	8,316	19,529	5,781	21,204	6,456
Chile	28,680	9,912	13,253	4,361	22,037	7,929	29,762	10,663
South British Africa	641,392	176,009	642,965	184,430	657,498	206,976	601,647	198,660
Portuguese Africa	107,818	32,212	90,206	28,403	38,060	12,798	72,464	27,249
China	22,241	7,345	28,426	9,862	23,498	8,104	31,217	10,588
All other countries	239,172	75,458	311,593	94,909	387,216	120,599	428,766	122,100
Total	2,187,727	631,690	2,615,138	750,748	2,846,575	844,826	2,725,964	790,274

Exported to—	1915		1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
England	842,694	$126,585	1,718,227	$242,433	2,210,903	$311,112	1,997,445	$618,432
Scotland	199,765	49,798	261,790	77,308	305,356	111,432	13,191	6,348
Ireland	186,537	44,361	79,174	21,326	.....	.....	50	25
Canada	435,802	134,865	37,242	8,266	21,095	4,328	617,310	240,559
Panama	78,503	20,557	115,905	31,418	140,330	27,316	91,175	19,385
Mexico	94,086	22,840	167,776	32,956	306,956	58,887	240,152	53,663
Newfoundland and Labrador	95,274	18,772	104,757	22,617	100,826	18,993	77,775	15,882
Cuba	43,066	12,324	67,903	18,556	59,318	16,232	116,340	36,331
South America:								
Argentine	117,157	41,119	148,276	51,707	148,511	54,309	242,617	81,287
Brazil	29,269	9,457	49,202	14,322	65,559	19,913	83,158	33,878
Chile	14,189	4,778	66,720	21,083	80,398	25,676	50,458	18,711
South British Africa	789,035	257,515	647,068	180,403	821,773	241,845	1,689,673	510,714
Portuguese Africa	92,562	30,419	80,344	24,161	40,738	10,843	55,350	16,543
China	25,679	8,910	20,799	7,941	55,784	17,794	34,491	16,543
All other countries	333,162	99,579	404,622	105,621	477,997	109,739	713,217	134,885
Total	3,376,780	881,879	3,969,805	860,118	4,835,544	1,028,419	6,022,402	1,838,808

DOMESTIC MANUFACTURERS.

The following five companies are engaged in making cream of tartar and tartaric acid in the United States: American Cream of Tartar Co., San Francisco, Calif.; E. I. Du Pont de Nemours Co., Harrison Works, Philadelphia, Pa.; Harshaw, Fuller & Goodwin Co., Cleveland, Ohio; Charles Pfizer & Co., New York, N. Y.; Tartar Chemical Works (subsidiary of Royal Baking Powder Co.), New York, N. Y.

PRICES.

The American prices for the refined tartaric products are shown in the following table compiled from the weekly market reports on or about the first of each month.

TABLE XXI.—*Wholesale prices of refined tartaric products at New York, 1913–1919.*[1]

[Cents per pound.]

TARTARIC ACID—CRYSTALS.

	1913		1914		1915		1916		1917		1918		1919	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
January	30¼	30¾	30½	.....	41	41½	52	55	66	70	78½	79½	81	86
April	30½	30¾	30½	31½	37½	38	63	77	76	82	75	77	86½	.....
July	30¼	30¾	.....	30¾	48	50	66	74	78½	82	86	89	86½	.....
October	30¼	30¾	.....	70	46½	47	66	70	78½	81	86	95	74	.....

TARTARIC ACID—POWDERED.

	1913		1914		1915		1916		1917		1918		1919	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
January	30½	31	31	.....	41½	42	51	55	67	70	78½	79	81	86
April	30½	31	31½	32	37½	38	62	71	76	82	76	78	87½	.....
July	30½	31	.....	30½	48	50	65	73	78½	82	85	88	87½	.....
October	30½	31	.....	70	46	47	65	.....	78½	81	85	93	74	.....

CREAM OF TARTAR—CRYSTALS.

	1913		1914		1915		1916		1917		1918		1919	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
January	23¾	24½	24½	24¾	28	30	37½	39	.....	40	55	60	69	69½
April	23¾	24½	24½	24¾	28	30	42½	46	45	46	59	61	63½	.....
July	23¾	24½	.....	23¾	35	.....	42½	44	49½	.....	66½	67	55	56
October	23¾	24½	.....	50	34	35	.....	40	50	50½	68½	69	55	56

CREAM OF TARTAR—POWDERED.

	1913		1914		1915		1916		1917		1918		1919	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
January	24	24½	24¾	25	28	30	37	39	.....	40	56	61	68½	69
April	24	24½	24¾	25	28	30	42½	46	45	46	54	61½	63	.....
July	24	24½	.....	24	35	.....	43	44½	49½	.....	67	67½	55	56
October	24	24½	.....	50	34	35	.....	40	56	61	69	69½	55	56

ROCHELLE SALTS.

	1914	1915	1916	1917	1918	1919
January	.....	20	29½–30	60	39 –39½	47 –47½
April	.....	21	33½	.....	39 –39½	47 –47½
July	.....	25	35½	.....	44½–46	43½–44
October	17½–18	27	60	39–39½	47 –47½	43½–44

[1] From Oil, Paint and Drug Reporter.

TABLE XXII.—*Comparison of wholesale prices of tartaric acid in the United Kingdom and in the United States, by quarters, 1913–1918.*[1]

Years—quarters.	Actual prices.		Relative prices.	
	United Kingdom.	United States.	United Kingdom.	United States.
Market	Manchester.	New York.		
Unit	Pound	Pound		
	£. s. d.	*Dollars.*		
Base price[2]	0 1 0.49	0.3054	100	100
1913.				
First	0 1 0.75	.3025	102	99
Second	0 1 0.25	.3025	98	99
Third	0 1 0.33	.3025	99	99
Fourth	0 1 0.50	.3158	100	103
1914.				
First	0 1 0.34	.3117	99	102
Second	0 1 0.79	.2917	102	96
Third	0 1 4.00	.2850	128	93
Fourth	0 1 8.00	.4258	160	139
1915.				
First	0 1 5.67	.3825	141	125
Second	0 1 6.58	.4167	149	136
Third	0 2 2.33	.4667	211	153
Fourth	0 2 4.17	.4800	226	157
1916.				
First	0 2 6.67	.5467	246	179
Second	0 3 9.00	.6500	360	213
Third	0 3 2.00	.6600	304	216
Fourth	0 2 8.33	.6600	259	216
1917.				
First	0 2 6.67	.6900	246	226
Second	0 2 11.00	.7683	280	252
Third	0 2 11.33	.7850	283	257
Fourth	0 2 11.00	.7850	280	257
1918.				
First	0 3 1.67	.7700	302	252
Second	0 3 4.67	.8133	326	266
Third	0 3 5.33	.8600	331	282
Fourth	0 3 8.00	.8433	352	276

[1] Source: International Price Comparisons, Department of Commerce, Washington, 1919.
[2] Average actual prices from July, 1913, to June, 1914.

SUBSTITUTES AND RIVAL COMMODITIES.

Baking powders containing cream of tartar were the earliest to be developed and the first to be largely used. Within the last decade, however, other varieties containing no cream of tartar have been placed on the market and are actively competing with cream of tartar baking powders. The cream of tartar (and tartaric acid) may be replaced by alum or a mixture of aluminum sulphate and sodium sulphate, by calcium acid phosphate, or by a mixture of alum and calcium acid phosphate.

Conflicting claims are made by interested parties in regard to the baking efficiency, keeping qualities, and cost of the different brands. A critical discussion of the relative merits of the different varieties of baking powder is outside the scope and purpose of this report. The continuance of competition indicates that the question is not one-sided.

However, such questions have only an indirect significance in the determination of tariff policy. To the student of tariff problems

the competition between different varieties of baking powders has a two-fold significance. The development of the newer varieties tends to diminish the revenue which the Government can collect from import duties on tartar materials. Any change in import duties on raw or crude tartar materials will have an influence on competition between the different varieties of baking powders or at least will affect the manufacturer's margin of profit.

The principal rival commodities of tartaric acid for use in foods and beverages have been citric and lactic acids. Citric acid has usually been preferred and because of its purity has commanded a higher price. In the future, edible lactic acid will probably offer increasingly severe competition to tartaric acid. (See chapter on lactic acid.)

TARIFF PROBLEMS.

There is no prospect that the United States can become independent of foreign supplies of these articles except by the development of a radically new synthetic process of making tartaric acid. Although a great deal of experimental work has been done on this process, its commercial success is still very problematical and it would as yet be premature to take it into consideration in the formation of a tariff policy. The American production of crude tartar materials never supplied more than an insignificant fraction of the domestic requirements and now that wine can no longer be made in the United States for commercial purposes, the only domestic supply will be the very small amounts obtained in the manufacture of unfermented grape juice.

The fundamental questions of tariff policy are, therefore: (1) Whether the American needs for cream of tartar and tartaric acid are to be met by the importation of crude materials (wine lees, argols, and calcium tartrate), or by the importation of the refined articles (cream of tartar, tartaric acid, and Rochelle salts); (2) whether these articles shall be made to yield a revenue to the Government; (3) whether it is desirable and possible to counterbalance the effect of the export duties now placed on crude tartar materials by some of the producing and exporting countries; and (4) whether the duties on the crude and refined materials should not be on the same basis (ad valorem or specific) in order to prevent fluctuations in price from affecting the protective margin allowed by the tariff.

The American needs for tartaric products have always been met by the importation of the crude or partially refined materials from which the cream of tartar and tartaric acid are further refined or manufactured. As will be seen in the following table during the period that the act of 1909 was in force, imports of the refined articles were only about 1 per cent of the imports of crude materials. The act of 1909 imposed a duty of 5 per cent on the crude materials and 5 cents per pound on the refined materials. During the life of this law, the total imports of crude materials amounted to 116,435,358 pounds, valued at $10,556,436, on which a total duty of $529,341 was collected. In the same period the imports of refined tartar products (cream of tartar, tartaric acid, and Rochelle salt) amounted to 1,303,320 pounds, valued at $222,297, on which a duty of $57,508 was collected.

TABLE XXIII.—*Total imports during life of the act of 1909.*

Crude tartar materials.	Rate.	Quantity.	Value.	Duties collected.	Ad valorem rate.
		Pounds.			*Per cent.*
Argols, or crude tartar or wine lees, crude	5 per cent	116,371,722	$10,548,737	$527,434	5
Argols, partly refined, or tartars and lees crystals, containing not more than 90 per cent of bitartrate of potash	3 cents per pound	63,636	7,699	1,907	24.77
Total crude products		116,435,358	10,556,436	529,341	

Refined tartar materials.	Rate.	Quantity.	Value.	Duties collected.	Ad valorem rate.
		Pounds.			*Per cent.*
Argols partly refined, or tartars and lees crystals, containing more than 90 per cent of bitartrate of potash	4 cents per pound	9,921	$1,962	$397	20.23
Cream of tartar	5 cents per pound	289,754	41,488	14,485	34.91
Tartaric acid	do	626,075	132,743	31,301	23.58
Rochelle salts	3 cents per pound	377,570	46,104	11,325	24.56
Total refined products		1,303,320	222,297	57,508	

The act of 1913 made no change in the rate of duty on the crude materials, but lowered the rate on cream of tartar from 5 cents per pound to 2½ cents per pound and on tartaric acid from 5 cents per pound to 3½ cents per pound. These changes in duty were followed during the next two years by a considerable increase in the imports of the refined articles although imports of the crude materials continued to be many times as large as the imports of the refined articles. In recent years imports of the refined articles have again decreased possibly on account of the disturbed conditions in Europe resulting from the war.

For a number of years before the war, the Italian Government imposed an export duty on the crude tartar materials. This tax amounted to 2.20 lire per 100 kilograms ($0.00193 per pound) and was levied on both argols and wine lees. In 1915 an additional war tax of 1 per cent ad valorem was imposed on both of these materials and in December, 1916, the war tax was increased to 2 per cent. The official statistical valuations upon which the war tax is levied are given as follows for 1914, 1915, and 1916:

Crude tartar and argols:

1914—130 lire per 100 kilos., equivalent to $0.113 per pound.
1915—190 lire per 100 kilos., equivalent to .166 per pound.
1916—245 lire per 100 kilos., equivalent to .205 per pound.

Wine lees:

1914—38 lire per 100 kilos., equivalent to .033 per pound.
1915—52 lire per 100 kilos., equivalent to .045 per pound.
1916—70 lire per 100 kilos., equivaleat to .061 per pound.

Thus in 1916 the total export tax on crude tartar amounted to approximately 3 per cent and on wine lees to slightly over 5 per cent.

These taxes handicap the American refiner by further increasing the cost of his raw material and at the same time cutting down the margin of profit on the refined products. Accordingly, if it is desirable that American needs for tartaric products be met by the refining of foreign crude materials, the duty on tartaric acid and cream of

tartar should be so adjusted as to counterbalance the export duties imposed on the crude materials by the producing countries.

The war has indirectly had the effect of decreasing the margin between import duties on the crude and refined products. The raw materials are subject to an ad valorem duty and since crude tartar and wine lees, along with nearly all other commodities, have about doubled in price since the outbreak of the war, the duty per pound has been increased proportionately. On the other hand the duty on the principal refined articles is a fixed specific duty and the general rise in prices has resulted in a decrease in the protective margin expressed as cents per pound or as its ad valorem equivalent.

TABLE XXIV.—*Rates of import duties on tartaric acid in principal countries.*

[Compiled from official texts on file in Bureau of Foreign and Domestic Commerce, Department of Commerce, and corrected to January 1, 1919.]

Countries.	Tariff No.	Foreign rates.	United States equivalents[1] (dollars per pound).
United States	1		$0.035.
United Kingdom		Free	Free.
France:			
General tariff[2]	238	18 francs per 100 kilos., net	$0.0157.
Minimum tariff	238	12 francs per 100 kilos., net	$0.0105.
Germany:			
General tariff	279	8 marks per 100 kilos	$0.0086.
Conventional tariff[3]	279	4 marks per 100 kilos	$0.0043.
Russia	108(5)	8.25 rubles plus 10 per cent per pood.	$0.1293.
Italy	37(u)	10 lire per quintal	$0.0087.
Canada:[4]			
British Preferential	208	5 per cent ad valorem	5 per cent ad valorem.
Intermediate	208	7½ per cent ad valorem	7½ per cent ad valorem.
General[2 5]	208	do	Do.
Australia:			
British Preferential	279	Free	Free.
General[2]	279	5 per cent ad valorem	5 per cent ad valorem.
Japan	156	11.90 yen per 100 kin	$0.0444.

[1] The conversions into United States currency are based on par value.
[2] The general rate applies to the United States.
[3] The conventional tariff applies to the United States except favors granted by the commercial treaties in force with Japan and Sweden.
[4] Tartaric acid crystals.
[5] Powdered tartaric acid is classified under paragraph 711 and bears a rate of duty of 20 per cent British Preferential and 25 per cent general rate.

TABLE XXV.—*Rates of import duties on crude tartar and cream of tartar in principal countries.*

[Compiled from official texts on file in Bureau of Foreign and Domestic Commerce, Department of Commerce, and corrected to Jan. 1, 1919.]

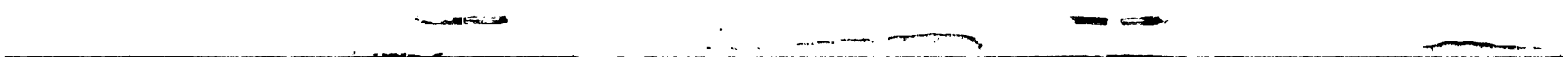
Countries.	Tariff No.	Foreign rate.	United States equivalents[1] (dollars per pound).
United States[2]			
Crude tartar	8		5 per cent ad valorem.
Refined tartar	8		$0.025.
United Kingdom		Free	Free.
France:			
Crude tartar	278	do	Do.
Other	278	do	Do.
Germany:			
Crude tartar[3]	311	do	Do.
Refined—			
General tariff	311	8 marks per 100 kilos	$0.0086.
Conventional tariff[4]	311	4 marks per 100 kilos	$0.0043.
Tartrate of soda	311	8 marks per 100 kilos	$0.0086.

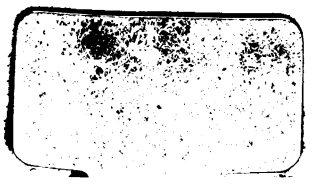
[1] Conversions into United States currency are based on par value.
[2] Argols or crude tartar or wine less crude or partly refined, containing not more than 90 per centum of potassium bitartrate; containing more than 90 per centum of potassium bitartrate, cream of tartar, and Rochelle salts or tartrate of soda and potassa, 2½ cents per pound.
[3] Semirefined tartar is treated as crude tartar.
[4] Prior to the war the conventional rate applied.

TABLE XXV.—*Rates of import duties on crude tartar and cream of tartar in principal countries*—Continued.

Countries.	Tariff No.	Foreign rate.	United States equivalents[1] (dollars per pound).
Russia:			
Tartar (cream of tartar) crude (not refined).	95	90 copeks plus 10 per cent per pood.	$0.141.
Tartar, semipurified (not in powder) with its natural tinge.	95	1 rouble, 12½ copeks plus 10 per cent per pood.	$0.176.
General tariff[1]	112	3.60 roubles per pood plus 10 per cent.	$0.0564.
Conventional tariff[1 2]	112	2.25 roubles per pood	$0.0320.
Italy:			
Tartar, crude[3]	83	Free	Free.
Cream of tartar	85	4 lire per quintal	$0.0035.
Canada:			
Cream of tartar, in crystals or argols.	ex. 208		
British preferential		5 per cent ad valorem	5 per cent ad valorem.
Intermediate		7½ per cent ad valorem	7½ per cent ad valorem.
General[4]		....do	Do.
Not otherwise enumerated	ex. 208		
British preferential		20 per cent ad valorem	20 per cent ad valorem.
Intermediate		25 per cent ad valorem	25 per cent ad valorem.
General[4]		....do	Do.
Argentina[5]	3, 254	13.50 centavos per kilo	$0.0590.
Australia:[6]			
General tariff	281	5 per cent	5 per cent.
British preferential	281	Free	Free.
Japan[7]	229	20 per cent ad valorem	20 per cent ad valorem.

[1] Tartar (cream of tartar) refined.
[2] The conventional rate held until Sept. 10, 1919.
[3] Scrapings of casks.
[4] The general rate is applied to the United States.
[5] Tartrate and bitartrate (cream of tartar) and "Seignet" salt.
[6] Cream of tartar; chemicals and drugs, n. o. s.
[7] Chemicals, n. o. s.





UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 65 AND 66 OF THE TARIFF ACT OF 1913

SOAPS
SALTS OF TIN AND BISMUTH AND RARE METALS

Paragraph 65:
- Tin chlorides
- Salts of—
  - Bismuth
  - Gold
  - Platinum
  - Rhodium
  - Silver
  - Tin

Paragraph 66:
- Castile soap
- Medicinal soaps
- Toilet soaps
- All other soaps

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PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and Index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Dr. C. Grinnell Jones and R. DeLong, of the chemical division of the commission's staff, and of others.

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TIN CHLORIDES.

[Par. 65, act of 1913. Ten per cent ad valorem.]

SUMMARY.

Description.—There are two important chlorides of tin, bichloride of tin and tin tetrachloride. The bichloride of tin as sold to the trade, under the name of tin crystals, contains about 53 per cent of tin. It is used for weighting silk, in dyeing and calico printing. Tin tetrachloride contains about 45 per cent of tin. It is used for weighting silk and as a mordant in dyeing. The silk industry requires about 3,000 tons of tin tetrachloride per year.

Domestic production.—The present production (1918) is estimated at about 3,500 tons of tin tetrachloride per year.

The preparation of tin chlorides has developed almost exclusively into the detinning of scrap tin by means of chlorine gas. The process originated in the plant of the Goldschmidt chemical works at Essen, Germany. The process, however, was soon established by the Goldschmidts in this country. In about 1913 another company began operations and at the present time (1918) there are three companies producing tin chlorides in the United States by the chlorine detinning process. The growth of the industry is dependent on the growth of the silk industry which is the largest consumer.

The production of tin salts evidently includes both bichloride and tetrachloride of tin as well as other salts of tin.

The production in 1914 is only seemingly smaller than in previous years. While up to 1909 the entire production of tin chlorides was in the form of aqueous solution, in 1914 almost the entire production of tetrachloride of tin was anhydrous.

Tin chlorides are produced at Chrome and Perth Amboy, N. J., and at Pittsburgh, Pa. The domestic production supplies the normal domestic demand. Tin chloride is one of the products which is an outlet for chlorine. Two of the plants produce their own chlorine electrolytically and at the same time get a valuable joint product, caustic soda. The other company buys its chlorine, liquefies it, and ships it to its plant for use in the production of tin chloride.

Price.—The price of tin chlorides is based on the market price of pig tin, and as the price of pig tin has increased between 50 and 100 per cent of the prewar price, the price of tin chlorides has increased correspondingly.

Tariff history.—The tin chlorides have not been mentioned by name in the tariff acts. The act of 1913, paragraph 65, reads: "Salts and all other compounds and mixtures of which * * * tin constitutes the element of chief value, 10 per cent ad valorem."

GENERAL INFORMATION.

Description and important uses.—There are two important chlorides of tin which are recognized in commerce as "bichloride of tin" and tin tetrachloride.

Anhydrous bichloride of tin or anhydrous stannous chloride, as it is designated in chemical nomenclature, is a chemical compound, composed of 62.6 per cent of tin and 37.4 per cent of chloride. It forms a crystallized hydrate ($SnCl_2 + 2H_2O$) containing two molecules of water and 53.1 per cent of tin which is called by the trade tin crystals. It is sometines called butter of tin, although this name is usually applied to the hydrate of tetrachloride of tin ($SnCl_4 + 5H_2O$). It is a solid fusing at 249.3° C. to a liquid which boils between 619 and 628° C.

Bichloride of tin or tin crystals is used in the weighting of silk and in dyeing and calico printing. It is a strong reducing agent and is employed as such in the chemical laboratory.

Anhydrous stannic chloride or tin tetrachloride ($SnCl_4$) contains 45.6 per cent of tin and 54.4 per cent of chlorine. It is a heavy mobile liquid having a specific gravity of 2.28 and boiling at 114° C. The liquid has a high refractive index and consequently presents a very brilliant appearance. When exposed to the air it emits dense white fumes and is finally converted into a crystalline hydrate ($SnCl_4 + 5H_2O$) containing 5 molecules of water. This hydrate is also formed, with the evolution of heat, by mixing stannic chloride with one-third its volume of water. This hydrate is sometimes known as "butter of tin" and by the dyers as "oxymuriate of tin."

If dissolved in water an aqueous solution of 50° to 60° Baumé is obtained containing 20 to 25 per cent of tin. This form of stannic chloride was exclusively produced up to 1909 when the production of anhydrous stannic chloride was taken up in this country. The trade calls the aqueous solution very incorrectly bichloride of tin, which fact gives occasion to many misunderstandings.

Tin tetrachloride is used as a mordant in dyeing and for the weighting of silk. This latter use is the largest use of tin tetrachloride. For the weighting of silk the tin tetrachloride must be very pure as any impurities tend to weaken the silk fibers.

Bichloride of tin and tin tetrachloride for the weighting of silk are known by the workmen in the silk mills as "dynamite" and the process of weighting is known as "dynamiting."

Raw materials.—The present raw materials used in the manufacture of tin chlorides in the United States are almost exclusively scrap tin, from the tin plate and tin can factories, and chlorine gas. It has been reported that one detinning company is using old tin cans as part of their raw material. (See the report on chlorine.)

The old method of making tin chlorides from metallic tin by means of hydrochloric acid has been practically abandoned in favor of the chlorine detinning process, which produces a product of a much higher degree of purity.

The amount of tin scrap used for the manufacture of tin chlorides in this country amounts to about 90,000 tons annually. The total amount of tin scrap available in the United States, including that imported from Canada, has been estimated at 175,000 tons per year. This amount may be exceeded during the period of the war, owing to the increased demand for tin cans. The tin scrap at the present time

contains 33 pounds of metallic tin per ton of 2,000 pounds. This gives a yearly consumption of about 1,500 tons of metallic tin by the detinning companies for the manufacture of tin chlorides. Each ton of tin scrap yields about 70 pounds of tin tetrachloride.

The import and export figures on scrap tin have been compiled from the Commerce and Navigation of the United States.

Process of manufacture.—The manufacture of tin chlorides has developed into the detinning of tin scrap by the means of chlorine gas. The tin chlorides may be made from metallic tin by means of hydrochloric acid, but this method has been unable to successfully compete against the chlorine detinning process, which produces a purer product.

The preparation of tin tetrachloride by the chlorine detinning process is carried out as follows: The scrap tin is packed in large iron wire baskets. In case the tin scrap is lacquered it is treated with a solution of caustic soda to remove the lacquer. The tin scrap is then dried by means of hot dry air. It is essential that the scrap tin be perfectly dry. The dried scrap is then treated with chlorine gas in a large iron cylinder. The chlorine readily combines with the tin on the scrap to form tin tetrachloride, which being a liquid drains out of the cylinder. Any tetrachloride which remains on the scrap may be recovered by applying heat and distilling it out of the cylinder, or the scrap may be removed from the cylinder, and the tetrachloride washed off and recovered. The scrap after being completely detinned is compressed into compact billets and sold to the steel mills. The crude tin tetrachloride is redistilled, giving a product of pure tin tetrachloride, which is sold as such, or it is converted into the crystals of hydrated tin tetrachloride by mixing with the theoretical amount of water. Stannous chloride or bichloride of tin can be made from tin tetrachloride by causing it to react with metallic tin.

The preparation of the tin chlorides by the chlorine detinning method is necessarily an industry operating on a tonnage basis, since each ton of tin scrap yields only about 70 pounds of tin tetrachloride. The industry requires considerable electricity for the production of chlorine, some power for handling the scrap, and steam for the distillation of the crude tin tetrachloride. It is essential that the process be under careful chemical control and supervision.

Until 1910 most of the tin chlorides were produced in aqueous solution, while since then the product has been principally the anhydrous tin chlorides. This accounts for the apparent decrease in production as shown on page 10.

History of the industry.—The chlorine detinning process of manufacturing tin chlorides originated about 1908 at the plant of the Goldschmidt chemical works at Essen, Germany. Prior to this time the tin chlorides were made by dissolving metallic tin in hydrochloric acid. The introduction of the chlorine process gave a product of a higher quality than that formerly produced and was therefore better suited for the weighing of silk. Scrap tin was purchased in all parts of the world and shipped to Germany to be detinned by means of chlorine.

The chlorine detinning process was soon established in this country by the Goldschmidts, and the scrap was treated in this country instead of shipping it to Germany. In 1913 another company began operations, and at the present time there are three companies that are detinning scrap tin in the United States by the chlorine process.

The present production of tin tetrachloride, which amounts to about 3,500 tons annually, is at least equal to the normal demand and may exceed the normal demand to a slight extent. The prospects of an increased production of tin tetrachloride as a further outlet for chlorine depends entirely on the growth of the silk industry in this country, since the silk industry is the only large user of tin chlorides in normal times. At the present there is a large war demand for tin tetrachloride which can not be met by the detinning companies.

It has been reported that Japan has been making inquiries as to purchases of tin chlorides and also has been purchasing tin scrap for export to Japan. This has the appearance that Japan is preparing to make tin chlorides in Japan evidently with the idea of weighting silk in that country. As long as the Japanese Government continues to guarantee the quality of silk exported and does not permit the weighting of the grade of silk which constitutes about 90 per cent of their exports there will be no serious competition from Japan in the manufacture of tin chlorides and the weighting of silk.

Tin salts (listed as tin salts in Census of Manufactures)—Production in United States—Official source.

[From Federal Census.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1899	6,259,794	$603,937	1909	10,293,377	$1,535,350
1904	11,621,378	1,361,299	1914	8,291,239	2,028,511

Bichloride of tin, 50 degree,[1] prices, cents per pound, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
	Cents.	*Cents.*	*Cents.*	*Cents.*
1912	13	12⅞	13½	13½
1913	14½	14½	14½	12½
1914	12½	11½–11⅞	11½–11⅞	13
1915	09¾–10	11⅜–12¼	11¼	11¼–11½
1916	13¾–14	15⅜–16	15¼–15⅜	13½–14
1917	13½–14	17½–18	17½–18	19¾–20½
1918	23¾–24½	24 –24½	28 –29	28 –29
1919	25¼–26	25¼–26	22½–25	18 –20
1920	20 –22	–20 22	19 –21	13¾–16½

[1] Erroneously called "bichloride of tin" by the trade. The article is an aqueous solution of tetrachloride of tin having a gravity of 50° B.

Tin crystals [1]—Tin chlorides—Prices (wholesale), cents per pound, spot, New York.

[From Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.	Lowest.	Highest.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1912	28½	28 –30	29½–31½	29 –30	28	31½
1913	31 –33½					
1915	23 –23½	26 –26½	26 –26½	25 –25½	23	26½
1916	28 –28½	32 –32½	35 –35½	29½–30	28	35½
1917	29½–30	35½–36	37½–38	39 –39½	29½	39½
1918	55 –56	55 –56	60 –61	65 –70	55	70
1919	65 –70	65 –70	48 –50	42 –42½	42	70
1920	42 –42½	45 –45½	43 –43½	35 –43	35	45½

[1] A hydrate of bichloride of tin containing 2 molecules of water.

Tin chlorides—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913....	65	Salts and all other compounds and mixtures of which * * * or tin constitute the element of chief value (see p. 13, infra.).....	10 per cent ad valorem.

Court and Treasury Decisions.

Chloride of tin in solution was held dutiable under paragraph 56 of the act of 1890 on the alcoholic content as spirit varnish and not exempt from duty as lac spirits. (G. A. 1504, T. D. 12953). But tetrachloride of tin was held exempt from duty under paragraph 593 of the act of 1897 as lac spirits and not dutiable as a chemical compound. (Consolidated Color and Chemical Co. *v.* United States, 2 Ct. Cust. Appls., 192.)

Domestic exports of tin scrap by countries.

Country.	1909	1910	1911	1912	1913	1914	1915	1916
Belgium.....	$9,060	$11,638	$18,873	$42,342	$19,530	$41,135	.....	.....
Germany.....	87,160	28,702	23,435	26,418	261	568	.....	.....
Netherlands.....	8,749	24,502	4,599	8,568	.....	9,328	$2,322	.....
Canada.....	.....	15	.....	.....	1,064	1,979	104	$3,967
France.....	.....	.....	.....	.....	.....	11,000	.....	.....
United Kingdom.....	.....	.....	.....	.....	.....	11,416	7,186	.....
All others.....	.....	.....	.....	.....	.....	.....	.....	198
Total.....	104,969	64,857	46,907	77,328	20,855	75,426	9,612	4,165

Imports of scrap tin by countries.

	1915		1916	
	Pounds.	Value.	Pounds.	Value.
United Kingdom.....	5,999,454	$26,113	12,066,346	$68,694
Canada.....	10,262,068	51,832	12,215,463	72,752
France.....	.....	.....	476,118	2,065
All others.....	149,461	1,419	273,526	2,145
Total.....	16,410,983	79,364	25,031,453	145,656

Imports for consumption of scrap tin.

Year.	Rate of duty.	Pounds.	Value.	Value per unit.
1914.....	Free.....	6,137,571	$45,367	$0.007
1915.....	.....do.....	14,999,622	78,255	.005
1916.....	.....do.....	24,908,625	145,666	.006
1917.....	.....do.....	17,119,515	121,966	.007
1918.....	.....do.....	17,718,044	115,963	.007

SALTS OF BISMUTH, GOLD, PLATINUM, RHODIUM, SILVER, AND TIN.

[Par. 65—act of 1913, 10 per cent ad valorem.]

SUMMARY.

Description.—Bismuth, gold, platinum, rhodium, silver and tin are less abundant than most of the other metals whose salts are used technically or medicinally. Gold, platinum and rhodium are rare metals and bismuth, silver and tin are not of common occurrence.

Uses.—The salts have widely varying uses. Gold, platinum and silver salts are used largely in photography; bismuth salts principally in medicine, and the manufacture of cosmetics; tin salts, principally in the textile industry. No record of technical or medicinal uses have been found for salts of rhodium.

Domestic production.—The value of these salts produced in 1914 is as follows:

Gold salts	$291,658
Platinum salts	6,998
Silver salts	846,059
Tin salts	2,028,511

Separate figures for the values of salts of bismuth and rhodium are not available.

Imports.—Imports of these salts have not been large and have shown a decrease since the beginning of the war. In 1915 the imports were valued at $24,685 and in 1918, at $5,988.

Exports.—No exports of salts of these metals are shown in Commerce and Navigation.

Tariff History.—Salts of bismuth, gold, platinum, rhodium, silver and tin were not specifically provided for in any of the tariff acts previous to 1913, and have therefore been dutiable at 25 per cent ad valorem as unenumerated salts. The effect and apparent intent of paragraph 65 of the 1913 act is to eliminate the salts of these relatively expensive metals from the general provisions of paragraph 5, which carries a duty of 15 per cent ad valorem, and make them dutiable at a lower rate of 10 per cent.

Prices.—The price of each of these is dependent on the market price of the metal from which it is derived and as the metals have increased in value since the beginning of the war, the salts have shown a corresponding increase.

GENERAL INFORMATION.

SALTS OF BISMUTH.

Description.—The most important salts of bismuth are the subnitrate, the subgallate, subcarbonate and oxychloride. Other salts of more or less importance are the oxide, salicylate, tannate, chloride, iodide, chromate, citrate, and pyrogallate.

Uses.—Bismuth salts are used in medicine, internally in cases of stomach and intestinal troubles and externally for affections of the skin, burns, etc. Technically they are used in the preparation of cosmetics, fluxes for enamels, etc.

Those of greatest technical value are the subnitrate and oxychloride. The chromate is sometimes used as a pigment.

Medicinally the subnitrate and subgallate are most used.

Domestic production.—Separate figures for the production of bismuth compounds are not available.

Imports.—Imports are not listed separately in Commerce and Navigation, but the total imports of bismuth, gold, platinum, rhodium, silver, and tin salts in 1915 were valued at $24,685. In 1916 the imports amounted to $10,922 and during 1918 the value of the imports dropped to $5,988.

According to the report of the Department of Commerce, the imports of bismuth salts for 1914 amounted to only 588 pounds, most of which came from Germany. The largest imports were of oxide and subgallate.

Exports.—No exports of bismuth compounds are shown in Commerce and Navigation.

Tariff history.—Previous to 1913 bismuth salts were not specially provided for, and were therefore dutiable at 25 per cent ad valorem as unenumerated salts. The act of 1913 made bismuth salts dutiable at 10 per cent ad valorem under paragraph 65.

Prices.—The price of bismuth salts has increased since the beginning of the war and in most cases reached a maximum in 1918, having remained fairly constant since then. The price of bismuth subnitrate in August, 1914, was $1.80 and $1.85 per pound, and in July 1918, had risen to $3.20 and $3.25, being still quoted at that figure in April, 1919. (For prices, see pp. 17 and 18.)

GOLD SALTS.

Description and uses.—There are very few gold salts which are of any practical importance. The chief ones are gold chloride, gold and sodium chloride, gold and potassium chloride, gold and tin purple (Purple of Cassius), and gold potassium cyanide.

Gold chloride and the double chlorides of sodium and potassium are used in photography; the chloride and double potassium cyanide are used for preparing electrolytic baths for gold plating and refining, and the purple of Cassius is used for coloring glass, for manufacturing enamels, and painting porcelain. Some gold salts are used to a slight extent in medicine. Gold salts are used as the coloring matter of ruby glass.

Domestic production.—The domestic production of gold salts in 1904 amounted to 47,641 ounces, valued at $453,202. In 1909 it was 42,544 ounces, valued at $430,944, but dropped in 1914 to 28,817 ounces, with a value of $291,658 (see p. 16).

Imports.—No separate imports are shown for gold salts in Commerce and Navigation.

Exports.—No exports of gold compounds are shown in Commerce and Navigation.

Tariff history.—Gold salts were listed under unenumerated salts, and were dutiable at 25 per cent ad valorem before the act of 1913,

when they were made dutiable under paragraph 65 at 10 per cent ad valorem.

Prices.—The prices of gold salts are largely dependent on the gold content and correspond roughly to the value of the gold in each compound.

PLATINUM SALTS.

Description.—The principal salts of platinum are the chloride, the double ammonium chloride, double potassium chloride, the double barium cyanide, double thorium cyanide, double lithium cyanide, lithium rubidium cyanide, and the sulphate.

Uses.—Platinum chloride is used in the preparation of platinum plating baths; in photography, for preparing platinized asbestos, etc., for catalyzers to be used in the manufacture of sulphuric acid by the contact process; for fixing microscopic preparations; for platinum mirrors and platinum luster on glass and porcelain. It is also used as a chemical reagent in the laboratory.

The double barium platinum cyanide, lithium platinum cyanide and lithium rubidium platinum cyanide are used to make visible the effects of the Roentgen rays and hence used in photography with these rays. Platinum thorium cyanide has the same uses as platinum barium cyanide. Platinum sulphate is used in microchemical work. The other salts are used principally in chemical analysis, especially for the analytical determination of potassium.

Domestic production.—In 1904 the domestic production of platinum salts was 19,068 ounces, valued at $175,682. Since then the production has declined, being 1,561 ounces in 1909 and only 365 ounces, valued at $6,998, in 1914.

Imports.—The imports of platinum salts have been small, amounting to only a few ounces in 1914, all of which came from Germany. Import figures since 1914 are not available.

Exports.—No exports of platinum salts are shown in Commerce and Navigation.

Tariff history.—Platinum salts were classified under unenumerated salts dutiable at 25 per cent ad valorem, until the act of 1913 when they were made dutiable under paragraph 65 at 10 per cent ad valorem.

Prices.—Prices for platinum salts are not listed but are dependent on the price of platinum, that being the constituent of chief value. As nearly all platinum is obtained from Russia, the price of platinum and platinum salts has increased greatly since the beginning of the war.

RHODIUM SALTS.

Rhodium is a very rare metal which is found associated with platinum. No record of any technical or medicinal uses has been found for salts of rhodium.

SALTS OF SILVER.

Description.—The most important salt of silver is the nitrate. When fused and solidified in the form of sticks it is known as lunar caustic. Other salts of silver are the cyanide, bromide, iodide, acetate, chloride, lactate, oxide, and phosphate. All silver salts are sensitive to light and therefore should be kept in the dark.

Uses.—Silver salts are used extensively in photography and in medicine.

Silver nitrate is used as a reagent in analytical chemistry; in the preparation of indelible inks; for dyeing hair, mother-of-pearl, etc.; for the preparation of silver plating solutions; for silvering mirrors; and in the manufacture of other silver compounds. The bromide and iodide of silver are used in photography, as is also the phosphate. The double potassium silver cyanide is used extensively in silver plating solutions. The acetate and lactate are used in medicine.

Manufacture.—Silver nitrate is produced by dissolving silver in nitric acid and crystallizing the product from water. The other salts are mostly made from the nitrate.

Domestic production.—The production of silver salts has steadily increased since 1899. In that year the production amounted to 1,606,108 ounces valued at $627,252, and in 1909 there were produced 2,030,399 ounces valued at $727,428. The production had increased to 2,563,238 ounces in 1914 with a value of $846,059.

Imports.—Imports of silver salts have been very small, most of that imported being pure compounds imported for some special purposes. In 1914 there were imported only 364 ounces of silver nitrate. Most of this came from England.

Exports.—No exports of silver salts are listed in Commerce and Navigation.

Tariff history.—Until the act of 1913 silver salts were classified as unenumerated salts and dutiable at 25 per cent ad valorem.

Prices.—The price of silver salts is dependent on the price of silver. In January, 1915, silver nitrate was listed at 31¼ and 33¼ cents per ounce, and in January, 1916, had risen to 34⅝ and 36⅝ cents per ounce. Since then the price showed a steady increase until in January, 1919, it sold for 65¼ and 66¼ cents per ounce. By April, 1919, the price had decreased slightly, being 63⅛ and 65⅛ cents per ounce. (See p. 17.)

TIN SALTS.

[See Tin chlorides, supra.]

Description and uses.—The most important salts of tin are the chlorides, oxide and sulphide.

Stannous chloride, known also as "tin salts" or "tin crystals," is used largely in dyeing and calico printing. It is also used as a laboratory reagent in analytical chemistry, in the manufacture of purple of Cassius, and to a limited extent in medicine.

Stannic chloride, known also as the bichloride, is largely used in dyeing and as a weighting material for silks before dyeing.

Stannic oxide is a white powder. It is a constituent of putty powder, which is used for polishing glass. It is also used in the manufacture of glazes and enamels and as a polish for finger nails.

Stannic sulphide is a yellow powder sometimes known as "mosaic gold" or "artificial gold." It is used for gilding or bronzing articles of wood, plaster of Paris, etc.

Other salts of tin of technical value are the acetate, oxalate, and tartrate, used as mordants, and the chromate, which is used for decorating porcelain.

Manufacture.—Stannous chloride is made by dissolving tin in concentrated hydrochloric acid. The tin salts crystallize and are

separated. The liquor remaining is sometimes also sold for its tin contents.

Stannic chloride may be made by dissolving tin in hydrochloric acid and oxidizing the product with sodium chlorate, but at present is usually made by treating tin scrap with dry chlorine gas obtained from liquid chlorine. Large quantities of tin scrap are used in this way.

Tin oxide may be made by heating molten tin in the air.

Domestic production.—The domestic production of tin salts in 1914 was 8,291,239 pounds, valued at $2,028,511. In 1909, the production was a little greater, but the value less (see page 17). This seemingly greater production was probably due to the fact that in 1909 a large part of the chlorides sold were in solution, while in 1914 most of the stannic chloride sold was in solid form.

Imports.—No imports of tin salts are listed in Commerce and Navigation, but the report of the Department of Commerce shows 577 pounds of tin chlorides, valued at $227, imported from Germany in 1914.

Exports.—No exports are shown in Commerce and Navigation.

Tariff history.—Previous to the act of 1913 tin salts were not specifically mentioned in the tariff acts, but were dutiable at 25 per cent ad valorem as salts not specially provided for. The act of 1913 placed a duty of 10 per cent on all salts of which tin constitutes the substance of chief value.

Prices.—Tin bichloride sold during 1914 for about 12 cents per pound, and the price remained fairly constant until 1917, when it began to rise. The increase continued until in the latter part of 1918 it sold for 29 cents per pound. In April 1919 it sold for 25½ and 26 cents per pound.

Tin crystals have shown a corresponding change in price, selling at about 25 cents per pound in 1915, and increasing to 65 and 70 cents in October, 1918. There was no fall in price up to April, 1919. Subsequent decline brought the price in October, 1920, to 35–43 cents.

Gold Salts—Production in United States.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Ounces.			*Ounces.*	
1899	12,347	$120,696	1909	42,544	$430,944
1904	47,641	453,202	1914	28,817	291,658

Platinum Salts—Production in United States.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Ounces.			*Ounces.*	
1899	8,112	$61,400	1909	1,561	$19,123
1904	19,068	175,682	1914	365	6,998

Silver Salts—Production in United States.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Ounces.			*Ounces.*	
1899	1,606,108	$627,252	1909	2,030,399	$727,428
1904	1,899,081	778,439	1914	2,563,238	846,059

Tin Salts—Production in United States.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1899	6,259,794	$603,937	1909	10,293,377	$1,535,350
1904	11,621,378	1,361,299	1914	8,291,239	2,028,511

Salts and all other compounds, etc.—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1914	10 per cent		$18,387	$1,838		10
1915	do		24,685	2,468		10
1916	do		10,922	1,092		10
1917	do		10,653	1,065		10
1918	do		5,988	598		10
1919	do		7,799	780		10
1920	do					10
1921	do					

Nitrate of silver—Prices per ounce.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
August, 1914	33½–35½	April, 1918	61½–63½
January, 1915	31½–33½	July, 1918	62½–64½
April, 1915	32½–34½	October, 1918	63½–64½
July, 1915	31 –33	January, 1919	65½–66½
October, 1915	31½–33½	April, 1919	63½–65½
January, 1916	34½–36½	July, 1919	67 –68
April, 1916	38½–40½	October, 1919	72½–73½
July, 1916	41½–43½	January, 1920	80 –81
October, 1916	43½–45½	April, 1920	78½–79½
January, 1917	46½–48½	July, 1920	58½–59½
October, 1917	57 –59	October, 1920	59 –60
January, 1918	53 –55		

Bismuth, salicylate (38 to 40 per cent)—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$1.60–$1.65	October, 1917	$3.15
January, 1915	2.30– 2.35	January, 1918	$3.15– 3.20
April, 1915	2.30– 2.35	April, 1918	3.35– 3.40
July, 1915	2.55– 2.60	January, 1919	3.35– 3.40
October, 1915	2.55– 2.60	April, 1919	3.35– 3.40
January, 1916	3.25	July, 1919	3.05– 3.10
April, 1916	3.90	October, 1919	3.05– 3.10
July, 1916	3.90	January, 1920	2.45– 2.50
October, 1916	3.90	April, 1920	2.45– 2.50
January, 1917	3.90	July, 1920	2.45– 2.50
April, 1917	3.90	October, 1920	2.45– 2.50
July, 1917	3.90		

Bismuth, subcarbonate, U. S. P.—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$2.10–$2.15	January, 1918	$3.25–$3.30
January, 1915	2.80– 2.85	April, 1918	3.50– 3.55
April, 1915	2.80– 2.85	July, 1918	3.50– 3.55
July, 1915	2.80– 2.85	October, 1918	3.50– 3.55
October, 1915	2.80– 2.85	January, 1919	3.50– 3.55
January, 1916	3.10	April, 1919	3.50– 3.55
April, 1916	3.40– 3.45	July, 1919	3.35– 3.40
July, 1916	3.40– 3.45	October, 1919	3.25– 3.40
October, 1916	3.40– 3.45	January, 1920	3.00– 3.05
January, 1917	3.40– 3.45	April, 1920	3.10– 3.15
April, 1917	3.40– 3.45	July, 1920	3.10– 3.15
July, 1917	3.40– 3.45	October, 1920	3.10– 3.15
October, 1917	3.25– 3.30		

Bismuth, Subgallate—Prices, per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$1.65–$1.70	January, 1918	$3.25–$3.30
January, 1915	2.35– 2.40	April, 1918	3.50– 3.55
April, 1915	2.35– 2.40	July, 1918	3.50– 3.55
July, 1915	2.35– 2.40	October, 1918	3.50– 3.55
October, 1915	2.35– 2.40	January, 1919	3.50– 3.55
January, 1916	2.65	April, 1919	3.50– 3.55
April, 1916	3.00– 3.05	July, 1919	3.30– 3.35
July, 1916	3.00– 3.05	October, 1919	3.30– 3.35
October, 1916	2.80– 3.00	January, 1920	2.75– 2.80
January, 1917	2.80– 3.00	April, 1920	2.85– 2.90
April, 1917	2.80– 3.00	July, 1920	2.85– 2.90
July, 1917	2.80– 3.00	October, 1920	2.85– 2.90
October, 1917	2.80– 3.00		

Bismuth, Subnitrate, Powder—Prices, per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$1.80–$1.85	January, 1918	$2.85–$2.95
January, 1915	2.50– 2.55	April, 1918	3.20– 3.25
April, 1915	2.50– 2.55	July, 1918	3.20– 3.25
July, 1915	2.50– 2.55	October, 1918	3.20– 3.25
October, 1915	2.50– 2.55	January, 1919	3.20– 3.25
January, 1916	2.80	April, 1919	3.20– 3.25
April, 1916	3.10– 3.15	July, 1919	3.00– 3.05
July, 1916	3.10– 3.15	October, 1919	3.00– 3.05
October, 1916	2.70– 3.15	January, 1920	2.75– 2.80
January, 1917	2.90– 3.00	April, 1920	2.85– 2.90
April, 1917	2.90– 3.00	July, 1920	2.85– 2.90
July, 1917	2.90– 3.00	October, 1920	2.85– 2.90
October, 1917	2.90– 3.00		

Bismuth, Tannate—Prices, per pound.

[From Oil, Paint, and Drug Reporter.]

Not quoted prior to 1918.

January, 1918	$2.90–$2.95	January, 1919	$3.10–$3.15
April, 1918	3.10– 3.15		

Bismuth, ammonium citrate, U. S. P.—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$2.50–$2.55	January, 1918	Nominal.
January, 1915	2.70– 2.75	April, 1918	$4.30–$4.35
January, 1916	3.25	July, 1918	4.30– 4.35
January, 1917	3.50	October, 1918	4.30– 4.35
April, 1917	3.50	January, 1919	4.30– 4.35
July, 1917	3.50	April, 1919	4.30– 4.35
October, 1917	3.50		

Bismuth, metallic (not quoted prior to 1918).

January, 1918	$2.85–$3.00	July, 1919	$5.80–$5.85
April, 1918	3.30– 3.35	October, 1919	5.80– 5.85
July, 1918	3.30– 3.35	January, 1920	5.70– 5.75
October, 1918	3.30– 3.35	April, 1920	5.80– 5.85
January, 1919	3.50– 3.65	July, 1920	5.80– 5.85
April, 1919	3.50– 3.65	October, 1920	5.80– 5.85

Tin, bichloride, 50 degree—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
August, 1914	11½–11¾	January, 1918	23½–24½
January, 1915	9½–10	April, 1918	Nominal.
April, 1915	14½–15	July, 1918	28 –29
July, 1915	11½–12	October, 1918	28 –29
October, 1915	11½–11½	January, 1919	25½–26
January, 1916	13½–14	April, 1919	25½–26
April, 1916	15½–16	July, 1919	22½–25
July, 1916	15½–15¾	October, 1919	21 –22½
October, 1916	13½–14	January, 1920	20 –22
January, 1917	13½–14	April, 1920	20 –22
April, 1917	13½–18	July, 1920	19 –21
July, 1917	19½–19¾	October, 1920	13¼–16½
October, 1917	19½–20¼		

Tin, crystals—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

	Cents.
August, 1914	23
January, 1915	23 -23½
April, 1915	23 -23½
July, 1915	23 -23½
October, 1915	28
January, 1916	28 -28½
April, 1916	28 -28½
July, 1916	28 -29
October, 1916	28 -29
January, 1917	29½-30
April, 1917	29½-30
July, 1917	29½-30
October, 1917	29½-30
January, 1918	55-56
April, 1918	55-56
July, 1918	55-56
October, 1918	65-70
January, 1919	65-70
April, 1919	65-70
July, 1919	48-50
October, 1919	47-47½
January, 1920	42-42½
April, 1920	45-45½
July, 1920	43-43½
October, 1920	35-43

Tin, oxide—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

August, 1914	$0.36 -$0.38
January, 1915	.38 - .40
April, 1915	.55 - .56
July, 1915	.44 - .45
October, 1915	.39 - .41
January, 1916	.46 - .48
April, 1916	.60 - .62
July, 1916	.46 - .48
October, 1916	.44 - .46
January, 1917	.46 - .50
April, 1917	.58 - .64
July, 1917	.64½
October, 1917	.64½- .65
January, 1918	$0.75-$0.85
April, 1918	.80
July, 1918	1.00- 1.10
October, 1918	.90- 1.00
January, 1919	.90- 1.00
April, 1919	.65- .70
July, 1919	.60- .63
October, 1919	.60- .63
January, 1920	.60- .63
April, 1920	.60- .63
July, 1920	.60- .63
October, 1920	.55- .58

Salts of Bismuth, etc.—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	92	* * * and all chemical compounds and salts, by whatever name known, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	76	* * * and all chemical compounds and salts, not specially provided for in this act.	Do.
1894	60	.....do.....	Do.
1897	3	.....do.....	Do.
1909	3	* * * and all chemical compounds, mixtures, and salts, * * *, not specially provided for in this section.	Do.
1913	65	Salts and all other compounds and mixtures of which bismuth, gold, * * * silver, * * * constitute the element of chief value.	10 per cent ad valorem.

Court and Treasury Decisions.

SALTS OF BISMUTH.

Subnitrate of bismuth was classified as a medicinal preparation under paragraph 75 of the act of 1890 against the importer's contention that it was exempt from duty under paragraph 506 as bismuth.—G. A. 586 (T. D. 11227).

An importation classified as a chemical compound under paragraph 5 of the act of 1913 was held dutiable as a *compound of bismuth* under paragraph 65. Counsel stipulated that the merchandise was a compound in chief value of bismuth.—Abstract 41257.

SILVER CHLORIDE.

Silver chloride was held dutiable as a chemical compound under paragraph 3 of the act of 1909 and not exempt from duty under paragraph 643 as sweepings of silver.—Abstract 23784 (T. D. 30828).

But the provision in paragraph 565 of the act of 1913 for sweepings of silver was held to be the proper classification of silver chloride consisting of a lumpy powder mixed with débris, and having the appearance of waste. The term "sweepings of silver" as therein used was interpreted to include not only so-called "buffings" broken off in the manufacture of silver articles, but also silver chlorides which come off as waste in the manufacturing processes and which can not be used commercially except for the reclamation of the silver therein, and paragraph 65, providing for salts of silver, was limited to salts of silver used commercially or chemically as such.—G. A. 8009 (T. D. 36924; abstract 41300, of 1917). Similar sweepings which were classified by the collector of customs as waste, not specially provided for, under paragraph 479 of the act of 1909, were held exempt from duty as sweepings of silver under paragraph 643 of that act.—United States *v.* Henderson, 5 Ct. Cust. Appls., 62 T. D. 34097), affirming Abstract 32848 (T. D. 3 3591).

SOAPS.

[Par. 66, act of 1913.]

SUMMARY.

Par. 66. "Soaps: Perfumed toilet soaps, 30 per centum ad valorem; medicinal soaps, 20 per centum ad valorem; Castile soap, and unperfumed toilet soap, 10 per centum ad valorem; all other soaps and soap powder not specially provided for in this section, 5 per centum ad valorem."

The ordinary soaps of commerce are the sodium or potassium salts of fatty acids (such as stearic, oleic, and palmitic) which occur in fats and oils. Castile soap is a special grade of toilet soap, when pure is made only from olive oil and soda lye but other vegetable oils are used in much of the soap sold as castile. There is no sharp distinction between toilet soaps, mentioned in the act of 1913, and common laundry soaps. There are only two or three unperfumed toilet soaps and one of these—Castile soap—is mentioned by name in the act of 1913. This division of soap into classes which have no sharp dividing line has caused considerable litigation in the courts. It is doubtful whether they serve any useful purposes and could be eliminated without seriously affecting the domestic industry and the intent of the act of 1913.

The manufacture of soap involves the treatment of a fatty acid or more often the glyceride of a fatty acid with an alkali, usually caustic soda. Glycerin is a by-product of soap making and is one of the most valuable products of the soap industry. Soaps according to the method of manufacture are classed as boiled, half-boiled, and cold-process soaps.

The domestic soap industry is well established and there is very little competition from foreign products. In regard to raw materials the industry relies to a large extent on products made in this country. In the case of special high-grade toilet soaps certain of the materials are imported—for example, olive and palm oil. Imports of soap have been less than 1 per cent of domestic production and have been valued at less than $850,000 per year. About 50 per cent of the imports are Castile soap. The domestic industry in 1914 was carried on by 371 establishments capitalized at over $92,000,000 with an annual output during the year of $127,942,441. The domestic production supplies over 99 per cent of the consumption.

Total soap—Summary table.

Year.	Domestic production (calendar year).	Imports for consumption (fiscal years).	Domestic exports (fiscal years).	Ratio to production.		Value (imports for consumption).	Amount of duty.	Equivalent ad valorem rate.
				Imports.	Exports.			
				Per cent.	*Per cent.*			*Per cent.*
1910[1]	$111,357,777	$761,665	$3,620,546	0.68	3.25	$761,665	$208,521	27.37
1911		829,142	4,046,981			829,142	271,164	32.70
1912		798,373	4,536,028			798,373	246,441	30.87
1913		755,355	4,629,567			755,355	240,468	31.83
1914	127,942,441	831,414	4,939,002	.65	3.86	831,414	153,471	18.46
1915		746,185	4,858,299			746,185	111,850	14.99
1916		606,792	6,319,758			606,792	88,649	14.61
1917		586,514	6,291,790			586,514	94,222	16.06
1918		337,991	9,140,712			337,991	56,872	16.83
1919		300,745	17,619,404			300,745	51,461	17.11
1920			22,728,084					

[1] Production for the calendar year 1909.

General Information.

DESCRIPTION.

Paragraph 66. "Soaps: Perfumed toilet soaps, 30 per cent ad valorem; medicinal soaps, 20 per cent ad valorem; castile soap, and unperfumed toilet soap, 10 per cent ad valorem; all other soaps and soap powder not specially provided for in this section, 5 per cent ad valorem."

The term "soap" in chemistry signifies the metallic salts of fatty acids (stearic, palmitic, oleic). In commerce the term is ordinarily confined to the water-soluble potassium and sodium salts of the fatty acids. The water insoluble soaps of lead, magnesium, and aluminum are, however, used for technical but not for household purposes.

Soaps may be classified into two general groups, "hard soaps" and "soft soaps." Hard soaps are soda soaps while the soft soaps are potassium soaps. A mixture of the two lyes, soda and potash, are used to give soaps intermediate between hard and soft. They are also classified according to the method of manufacture as boiled soaps, half-boiled soaps, and cold-process soaps.

The term toilet "soap" is used to distinguish those soaps used for toilet purposes from the cheaper soaps used for laundry purposes. There are certain soaps used both for toilet and laundry purposes, so the term "toilet soap" is rather vague and has caused litigation. The tariff act of 1913 makes a distinction between toilet soap perfumed and unperfumed. Soap stock as a rule has a very unpleasant odor, which prevents its being used directly for toilet purposes. Therefore, some substance, usually a perfume material, is added to neutralize the unpleasant or to impart a pleasant odor. Besides castile soap, which is provided for by name in the present law, there are one or two other real unperfumed toilet soaps. Castile soap is made from olive oil and soda lye and therefore it does not have the disagreeable odor of most soap stocks. The other unperfumed soaps are cold-process glycerin soaps. The distinction could be eliminated without seriously affecting the intent of paragraph 66 and at the same time remove the cause of litigation.

Medicinal soaps are those containing some substance which possesses antiseptic or healing properties. The most common antiseptics used are carbolic acid and cresylic acid.

Pure castile soap is made from olive oil and soda lye only, but much of the soap marketed as castile soap is made from or adulterated with soap made from other oils. Practically all of the castile soap is made by the cold or half-boiled process.

DOMESTIC PRODUCTION.

Materials.—The raw materials used in the manufacture of soap are many and varied. The chief ones are tallow, grease, and other fats; coconut, palm, palm-kernel, cottonseed, olive, and other vegetable oils; vegetable waxes; and rosin. In addition large quantities of soda ash, caustic soda, and silicate of soda are used. The quantities of many of these articles consumed by the industry are shown on page 26.

The following table shows the fats and oils consumed by the soap industry in 1917. (From "The Production and Conservation of Fats and Oils in the U. S.," Dept. of Agr., Bull. No. 769 and Supplement.)

Vegetable fats and oils:	Pounds.
Chinese vegetable tallow	6,417,000
Chinese nut oil	115,000
Coconut oil	168,602,000
Corn oil	15,997,000
Cottonseed oil	126,390,000
Linseed oil	1,006,000
Olive oil	1,731,000
Palm-kernel oil	4,762,000
Palm oil	27,345,000
Peanut oil	15,126,000
Rapeseed oil	5,972,000
Sesame oil	5,000
Shea-nut oil	2,487,000
Soy-bean oil	124,058,000
All other vegetable oils	9,692,000
Total	509,705,000
Animal and fish fats and oils:	
Bone grease	37,032,000
Garbage grease	63,118,000
Herring oil	4,104,000
Lard	7,481,000
Lard, neutral	166
Menhaden	2,279,000
Neat's-foot oil and stock	118,000
Recovered grease	12,680,000

Animal and fish fats and oils—Contd.	Pounds.
Sperm oil	17,000
Tallow	362,297,000
Tankage grease	15,475,000
Whale oil	5,732,000
Wool grease	233,000
All other fish and animal oils	9,257,000
Total	519,823,166
Secondary fats and oils:	
Acidulated soap stock	25,086,000
Cottonseed foots	67,369,000
Cottonseed foots (distilled)	8,872,000
Fatty acids	35,050,000
Fatty acids (distilled)	39,465,000
Grease stearin	19,146,000
Lard oil	1,436,000
Oleo oil	108,000
Olive-oil foots	4,761,000
Red oil	12,812,000
Nonclassified [1] totals	25,000,000
Total	239,105,000
Grand total	1,268,633,166

PROCESS OF MANUFACTURE.

The manufacture of soap involves the action of a caustic alkali (usually caustic soda) on fatty acids (stearic, palmitic, oleic) or more often the glycerides of these acids. This operation is known as saponification. This produces an alkali salt of the fatty acids (soap) and a by-product glycerin. The glycerine is recovered from the waste lye liquors and is a very valuable by-product in the soap industry. A newer method (Twitchell process) separates the fat or oil into glycerin and fatty acid before treatment with alkali. This process gives a larger yield of a purer and stronger crude gylcerin.

The manufacture of soap may be classified under the following three processes:

1. Boiled soaps.
2. Half-boiled soaps.
3. Cold-process soaps.

[1] Firms under this head failed to classify consumption of fats and oils.

Boiled soaps, as the name indicates, are prepared by boiling the fat or oil with a solution of caustic alkali. After the reaction is completed the soap is "salted out" and rises to the top and the salt solution containing the glycerin settles to the bottom and is drawn off. The glycerin is later recovered from this solution by evaporation. Strong lye is now added to the soap and in the case of yellow soaps rosin is introduced or in the case of white soaps tallow or coconut oil is used. When the rosin or oil is completely saponified the kettle is allowed to stand for several hours, when the lye is drawn off. Water is now added and the soap boiled until it loses its granular appearance. It is then allowed to stand for several days. The contents of the kettle separate into three layers. The soap on the top, the lye on the bottom, and between these two a dark-colored layer, called the "nigre." The two lower layers are drawn into separate tanks and the soap is pumped to the "crutcher," which is an efficient mixer. Here perfume and any filling material, such as silicate of soda, soda ash, and borax, are added and thoroughly mixed with the soap. The soap is run from the crutcher into a "frame," where it is allowed to cool. It is then run through a "slabber," which cuts the soap into slabs of the desired thickness and width. These slabs are then cut into rough bars, which are dried and then run through a press which forms them into the commercial bar and stamps the trademark or other design on the bar. These finished bars then pass to automatic wrapping and boxing machines.

Half-boiled soaps are made by treating the oil or fat with caustic alkali in the "crutcher" at a temperature of about 160° F. The mixture is crutched for a short time (about five minutes) and then allowed to stand for two hours. It is then crutched again until smooth, tested for excess alkali or fat, and then run into "frames." The treatment from this point is the same as described under boiled soaps. Half-boiled soaps contain all of the glycerin combined with the raw material, and therefore it is a very satisfactory soap for toilet purposes. As there is no recovery of the glycerin in this process, it can not be used economically for laundry soaps.

Cold-process soaps differ from the half-boiled soaps in that the oils and fats are only heated to their melting point and the caustic alkali added. The operation is the same as in the case of half-boiled soaps.

ORGANIZATION.

The capital invested in 371 establishments manufacturing soap in 1914 was over $92,000,000, which is an increase over the year 1909 of about $20,000,000. The industry employed an average of over 14,000 wage earners, who were paid $8,087,937 in wages. The number of salaried employees was 5,415, with salaries aggregating $6,691,692. The cost of the materials consumed by the industry was $88,866,786 and the value of the products was $127,942,441.[1]

GEOGRAPHIC DISTRIBUTION.

The soap industry is rather widespread, although the greater portion of it is located east of the Mississippi, which is the largest consuming district. In 1914 New York and Illinois each produced soap

[1] Census of Manufactures, 1914, Department of Commerce.

valued at over $20,000,000, while the production of New Jersey, Ohio, and Pennsylvania were each valued above $10,000,000. The other States which produce three to five million dollars' worth of soap are Missouri, Massachusetts, Wisconsin, Indiana, and California.

DOMESTIC PRODUCTION AND CONSUMPTION.

The domestic production supplies over 99 per cent of the value of the soap consumed in the United States, as the import of soap has been less than 1 per cent of the value of the domestic output. The present production of soap is undoubtedly greater than in 1914, as our exports have increased since then by more than $4,000,000.

EXPORTS.

The exports of soap have shown a steady increase from $3,620,546 in 1910 to a maximum of $17,619,404 in 1919. The export in 1914 was about 4 per cent of the value of the domestic production. The increase in the total value of soap exported is found in the increase in the export of soap other than "toilet or fancy." The export of "all other soap" has increased from 45,716,414 pounds, valued at $2,140,676, in 1910, to 82,726,757 pounds, valued at $6,894,454, in 1918; 157,749,605 pounds, valued at $15,266,696, in 1919.

The export of "toilet or fancy" soap has been chiefly to the United Kingdom, Canada, Argentina, Australia, and Cuba. Prior to 1917 the United Kingdom took between 15 and 25 million pounds of the domestic export of "all other soap." Since 1916 Mexico has taken the largest quantity of "all other soap," which in 1918 was over 27,000,000 pounds valued at more than $2,000,000. Other large consuming countries of domestic exports of soap are Canada, Panama Cuba, Haiti, Argentina, Dominican Republic, and France.

IMPORTS.

The imports of soap have been valued at less than $850,000. The import has been less than 1 per cent of the value of the domestic output. The import declined during the war to a value of about $340,000 in 1918.

About 50 per cent of the soap imported is Castile and the greater part of the remainder is high-grade toilet soaps. Very little of the cheaper grades of soap are imported.

TARIFF HISTORY.

Soaps of all kinds have been dutiable under all tariff acts since 1883. Castile soap carried an ad valorem duty of 20 per cent in the acts of 1883 and 1894, a specific duty of 1¼ cents per pound in the acts of 1890, 1897, and 1909, and 10 per cent ad valorem under the act of 1913. The specific duty in 1909 was equivalent to an ad valorem duty of about 17 per cent.

"Fancy, perfumed, and all descriptions of toilet soap" was dutiable at 15 cents per pound in the acts of 1883 and 1890. In the acts of 1894 and 1897 medicinal and medicated soaps were added to the

provision for toilet soaps and the duties were 35 and 15 per cent ad valorem, respectively. Toilet and medicinal soaps carried different duties under the acts of 1909 and 1913. "Fancy and perfumed toilet soaps were dutiable at 50 per cent ad valorem in the act of 1909. The act of 1913 divided toilet soaps into "perfumed" and "unperfumed" with duties of 30 and 10 per cent ad valorem, respectively. Medicinal soaps were dutiable at 20 cents per pound under the act of 1909 and at 20 per cent ad valorem under the act of 1913.

All other soaps n. s. p. f. have been dutiable at 20 per cent ad valorem under the acts of 1883, 1890, 1897, and 1909; at 10 per cent ad valorem under the act of 1894; and "all other soaps and soap powder" n. s. p. f. at 5 per cent ad valorem under the act of 1913.

TARIFF CONSIDERATIONS.

The soap industry is firmly established in the United States, and there is very little competition from imported products. The competition among domestic producers is keen. The industry is well situated in regard to raw materials. The imports are of high-grade toilet soaps, and there is practically no import of the common grades of soap and soap powders. The domestic industry has developed an export trade which in 1918 amounted to $9,000,000. It is evident that there is no special tariff problem in connection with the soap industry so far as foreign competition is concerned.

As pointed out in preceding pages there is no clear distinction between toilet and laundry soaps. Also there are only two or three strictly unperfumed toilet soaps and one of these—Castile soap—is mentioned by name in the act of 1913. These distinctions have caused litigation, which could be eliminated by making all soap dutiable at the same rate, preferably ad valorem in view of the numerous grades of soap. This could be done without destroying the intent expressed in the act of 1913 and without serious inconvenience to the domestic industry.

Soap industry—Domestic production.

[From Census of Manufacturers, 1914.]

	1914	1909	1904
Number of establishments	513	526	.....
Soap industry	371	420	436
Manufacturing subsidiary soap products	142	106	.....
MATERIALS.			
Total cost	$88,866,786	$72,179,418	$43,625,608
Tallow, grease, and other fats:			
Pounds	546,289,571	413,969,787	475,618,277
Cost	$32,565,899	$23,341,905	$19,723,311
Coconut and palm-kernel oil:			
Gallons	13,225,330	11,856,337	6,833,132
Cost	$9,406,583	$5,875,294	$2,692,034
Cottonseed oil:			
Consumption, gallons	16,144,786	26,611,810	14,196,416
Purchased—			
Gallons	15,903,691	24,221,712	13,276,006
Cost	$6,700,688	$9,718,988	$3,882,987
Produced and consumed, gallons	241,095	2,390,098	920,410
Rosin:			
Pounds	185,310,786	207,296,447	168,107,246
Cost	$4,067,992	$4,362,412	$2,734,848
Foots:			
Pounds	123,032,886	94,050,892	59,761,740
Cost	$6,456,784	$2,453,609	$1,222,982

Soap industry—Domestic production—Continued.

	1914	1909	1904
MATERIALS—continued.			
Caustic soda:			
Tons (2,000 pounds)	55,320	52,172	71,551
Cost	$1,936,575	$2,212,232	$2,843,988
Soda ash:			
Tons (2,000 pounds)	140,983	121,016	53,777
Cost	$1,997,575	$2,281,787	$1,011,694
All other materials	$25,734,690	$21,933,191	$9,513,764
Produced in works where consumed:			
Red oil, gallons	3,653,557	3,128,736	1,149,346
Tallow, pounds	5,331,000	16,664,000	10,613,000
Cottonseed oil, gallons	241,095	2,390,098	920,410
Caustic lye (30° Baumé), gallons	22,777,000	15,804,000	9,569,000
Sodium silicate, pounds	43,197,255	37,466,246	1,597,886
Glycerin, pounds	2,156,591	5,879,279	3,433,359
Framed soap, pounds	618,096,000	524,775,000	.....
PRODUCTS.			
Total value	$135,304,499	$115,455,190	$72,110,023
Soap industry	$127,942,441	$111,357,777	$68,274,700
Subsidiary products	$7,362,058	$4,097,413	$3,835,323
Hard soaps:			
Total quantity, pounds	2,064,228,000	1,794,249,000	1,386,610,000
Tallow soap	938,447,000	944,409,000	.....
Olein soap	42,524,000	33,696,000	.....
Foots soap	111,063,000	73,444,000	.....
Toilet soap	169,926,000	111,571,000	.....
Powdered soap	367,744,000	301,176,000	.....
Soap chips	97,746,000	329,953,000	.....
All other hard soaps	336,778,000		.....
Value	$104,464,542	$91,064,466	$58,027,406
Soft soaps:			
Pounds	57,002,000	60,037,000	43,899,000
Value	$1,697,424	$1,269,187	$761,081
Special soap articles	$832,654	$706,177	$554,881
Glycerin:			
Crude for sale—			
Pounds	12,745,336	.....	.....
Value	$1,817,536	.....	.....
Refined pounds	34,831,082	6,790,282	5,401,520
For sale—			
Pounds	32,674,491	.....	.....
Value	$5,775,887	.....	.....
Produced and consumed, pounds	2,156,591	5,879,279	3,433,359
Lye:			
Pounds	23,346,000	.....	.....
Value	$891,265	.....	.....
Perfumes and toilet preparations	$6,804,508	$15,625,078	$7,365,135
Candles	$150,492		
All other products	$12,870,191	.....	.....

Soap[1]*—Production in United States.*

[From Federal census.]

States.	1904	1909	1914
California	$1,600,000	$1,576,000	$2,968,000
Connecticut	1,061,000	1,528,000	.....
Illinois	14,157,000	20,181,000	21,420,000
Iowa	1,014,000	1,382,000	1,418,000
Indiana	.....	.....	2,980,000
Massachusetts	2,515,000	4,283,000	4,671,000
Missouri	3,113,000	4,719,000	4,920,000
New Jersey	4,018,000	13,674,000	16,692,000
New York	13,402,000	23,583,000	27,526,000
Ohio	11,791,000	17,077,000	[2]
Pennsylvania	6,959,000	9,124,000	10,098,000
Wisconsin	1,002,000	1,611,000	2,894,000
All other	7,643,000	12,620,000	32,355,000
Total	68,275,000	111,358,000	127,942,000

[1] Includes value of glycerin, a by-product of the soap industry
[2] Not available.

Soap, Castile—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1910	1½ cents per pound.	5,129,634	$395,417	$64,120	$0.077	16.22
1911	do	4,573,057	364,200	57,163	.080	15.69
1912	do	5,034,248	388,442	62,928	.077	16.20
1913	do	4,656,264	357,883	58,203	.077	16.26
1914 [1]	do	1,207,151	97,559	15,089	.081	15.47
1914 [2]	10 per cent	3,397,766	270,745	27,074	.080	10.00
1915	do	4,067,667	341,083	34,108	.084	10.00
1916	do	3,245,545	335,775	33,557	.103	10.00
1917	do	2,390,356	306,126	30,612	.128	10.00
1918	do	1,027,148	147,286	14,728	.145	10.00
1919	do	954,734	143,787	14,378	.150	10.00
Calendar year:						
1919	do	1,325,007	222,698	22,270	.167	10.00
1920 (6 months)	do	1,413,632	248,804		.175	10.00

[1] Act of 1909, July 1 to Oct. 3, 1913. [2] Act of 1913, Oct. 4, 1913, to June 30, 1914.

Soap, perfumed toilet [1]—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1910 [2]	15 cents per pound.	67,516	$30,728	$10,127	$0.455	32.96
1910 [3]	50 per cent	497,627	208,718	104,359	.419	50.00
1911	do		380,041	190,020		50.00
1912	do		324,050	162,025		50.00
1913	do		323,715	161,857		50.00
1914 [4]	do		66,714	33,357		50.00
1914 [5]	30 per cent		180,763	54,229		30.00
1915	do		192,978	57,893		30.00
1916	do		146,891	44,067		30.00
1917	do		183,136	54,940		30.00
1918	do		116,866	35,059		30.00
1919	do	130,065	109,218	32,765	.839	30.00
Calendar year:						
1919	do	182,318	143,959	43,188	.788	30.00
1920 (6 months)	do	123,086	67,049		.544	30.000

[1] "Fancy, perfumed, and all descriptions of toilet soap, including medicinal or medicated" included under act of 1897.
[2] Act of 1897, July 1 to Aug. 5, 1909.
[3] Act of 1909, Aug. 6, 1909, to June 30, 1910.
[4] Act of 1909, July 1 to Oct. 3, 1913.
[5] Act of 1913, Oct. 4, 1913, to June 30, 1914.

Soap, unperfumed toilet—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1914	10 per cent		$100,650	$10,065		10.00
1915	do		140,048	14,004		10.00
1916	do		82,057	8,205		10.00
1917	do		64,570	6,457		10.00
1918	do		13,635	1,363		10.00
1919	do	39,151	12,110	1,211	$0.309	10.00
Calendar year:						
1919	do	55,415	17,910	1,791	.323	10.00
1920 (6 months)		49,920	9,484		.190	10.00

Soap, medicinal or medicated[1]*—Imports for consumption—Revenue.*

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1910	20 cents per pound.	30,532	$8,206	$6,106	$0.272	73.51
1911	do.	50,182	15,614	10,036	.310	64.27
1912	do.	32,514	11,625	6,052	.358	55.94
1913	do.	42,517	14,734	8,503	.347	57.72
1914[2]	do.	5,023	2,363	1,004	.470	42.52
1914[3]	20 per cent	68,260	26,445	5,289	.387	20.00
1915	do.	32,048	14,082	2,816	.438	20.00
1916	do.	16,449	3,521	704	.214	20.00
1917	do.	4,287	1,975	395	.462	20.00
1918	do.	16,844	7,412	1,482	.440	20.00
1919	do.	9,701	8,835	1,767	.910	20.00
Calendar year:						
1919	do.	12,360	9,427	1,885	.762	20.00
1920(6 months)	do.	4,628	2,493		.539	

[1] See No. 4114 for imports under act of 1897.
[2] Act of 1909, July 1 to Oct. 3, 1913.
[3] Act of 1913, Oct. 4, 1913, to June 30, 1914.

Soap, all other, n. s. p. f.—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1910	20 per cent		$118,022	$23,604		20.00
1911	do.		68,806	13,761		20.00
1912	do.		73,586	14,717		20.00
1913	do.		58,525	11,705		20.00
1914[1]	do.		18,998	3,799		20.00
1914[2]	5 per cent		65,745	3,287		5.00
1915	do.		53,940	2,697		5.00
1916	do.		18,245	912		5.00
1917	do.		21,406	1,070		5.00
1918	do.		31,639	1,581		5.00
1919	do.	151,506	14,983	749		5.00
Calendar year:[3]						
1919	do.	236,457	22,579	1,129	$0.095	5.00
1920(6 months)	do.	86,133	11,458		1.332	5.00

[1] Act of 1909, July 1 to Oct. 3, 1913.
[2] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[3] Includes soap powder previously listed separately.

Soap powder—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	5 per cent		$211	$10		5
1915	do.		3,362	168		5
1916	do.		19,568	978		5
1917	do.		7,800	390		5
1918	do.		12,744	637		5
1919	do.	271,672	11,812	591	$0.043	5
1920 (6 months)	do.	12,975	1,272	63		5

Soap, toilet or fancy—Domestic exports.

Exported to—	Fiscal years.					
	1910	1911	1912	1913	1914	1915
France	$27,173	$32,683	$33,319	$40,710	$34,335	$25,059
Germany	11,893	20,899	19,624	24,020	23,370	3,113
United Kingdom	416,820	440,037	393,063	444,641	495,001	543,841
Canada	185,637	222,757	228,043	274,657	326,248	235,779
Panama	19,118	32,016	24,639	31,308	30,215	34,261
Mexico	36,529	51,333	56,654	69,459	46,966	29,895
Cuba	47,935	62,091	57,534	64,685	60,772	75,059
Argentina	185,704	209,838	277,076	263,740	261,712	101,158
Brazil	41,488	29,195	23,288	43,661	37,322	9,383
Chile	59,327	68,266	89,974	113,862	91,330	43,046
British India	23,641	37,624	27,477	48,151	42,871	41,120
Australia	159,172	201,837	220,856	227,397	228,164	200,391
New Zealand	38,138	47,201	48,139	71,250	66,882	52,386
Philippines	26,571	44,501	62,941	61,425	74,044	69,832
British South Africa	30,498	35,757	34,611	43,514	39,986	49,109
All other	170,226	205,936	242,799	310,183	282,415	263,910
Total	1,479,870	1,741,971	1,840,037	2,132,663	2,141,633	1,777,342

Exported to—	Fiscal years.			Calendar years.	
	1916	1917	1918	1918	1919[1]
France	$56,321	$33,960	$84,748	$39,072	$237,804
Germany	176				139,707
United Kingdom	681,299	29,032	5,471	39,944	629,723
Canada	285,602	333,679	399,516	398,778	414,790
Panama	68,928	74,389	51,614	55,921	61,321
Mexico	58,285	126,317	129,004	165,259	197,896
Cuba	135,340	148,881	313,810	386,172	403,905
Argentina	195,581	183,369	184,355	205,630	159,967
Brazil	17,029	22,637	39,108	48,790	64,954
Chile	66,610	127,790	173,327	171,063	98,049
British India	67,018	72,096	120,409	140,508	217,827
Australia	206,627	55,490	4,268	6,157	181,925
New Zealand	68,449	45,209	568	501	88,583
Philippines	96,110	103,246	126,275	144,203	324,855
British South Africa	68,065	58,446	61,824	57,462	85,850
All other	539,041	708,133	551,961	708,154	2,727,074
Total	2,610,481	2,122,674	2,246,258	2,567,614	6,034,230

[1] Total exports for 9 months 1920 were valued at $4,430,480.

Soap, all other—Domestic exports (fiscal years).

Exported to—	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	134,515	$5,717	483,570	$17,439	479,256	$19,100
United Kingdom	21,258,875	958,114	20,179,879	882,959	28,310,105	1,025,407
Canada	4,808,571	273,133	5,405,396	327,920	7,400,922	436,879
Panama	3,322,211	123,903	3,375,528	139,611	3,390,114	149,295
Cuba	1,365,740	90,885	1,793,811	104,180	1,987,087	121,402
Santo Domingo	1,596,585	66,755	1,358,032	65,269	1,583,072	78,867
Haiti	6,834,022	302,779	7,793,203	392,868	8,468,971	433,955
Mexico	262,329	14,751	168,398	9,814	418,438	23,704
Argentina	789,277	58,179	851,083	63,432	1,234,030	93,758
Colombia	517,052	21,733	712,156	30,085	790,593	34,979
Peru	564,733	24,706	697,388	31,170	660,307	29,671
Japan	337,937	21,530	318,086	19,293	158,387	13,739
Philippines	582,503	28,423	701,560	41,244	2,073,963	96,952
All other	3,342,064	150,068	3,743,169	179,726	2,900,212	138,283
Total	45,716,414	2,140,676	47,581,259	2,305,010	57,855,457	2,695,991

Soap, all other—Domestic exports (fiscal years)—Continued.

Exported to—	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	1,244,329	$51,039	1,884,776	$62,960	1,174,978	$40,328
United Kingdom	15,905,258	630,186	15,138,705	612,597	16,200,169	670,719
Canada	9,209,643	559,324	9,637,562	556,120	10,763,680	607,946
Panama	3,426,689	149,818	3,523,758	151,070	2,969,406	128,300
Cuba	2,189,181	132,114	2,251,278	137,073	2,649,472	160,794
Santo Domingo [1]	1,396,945	68,185	1,493,510	72,735	2,313,652	114,107
Haiti	8,904,655	442,869	9,226,300	455,524	6,710,961	354,262
Mexico	507,864	28,697	4,750,383	239,124	6,873,482	338,065
Argentina	1,238,846	88,414	778,539	58,377	510,166	41,425
Colombia	583,423	25,112	711,760	32,096	681,347	29,146
Peru	486,647	22,616	324,097	15,069	163,836	7,554
Japan	365,387	22,980	121,207	10,534	32,086	2,129
Philippines	3,094,878	143,578	5,823,873	253,429	7,613,634	364,196
All other	2,739,209	132,172	2,881,015	160,661	4,650,881	221,986
Total	51,292,954	2,496,904	58,546,763	2,797,369	63,367,750	3,080,957

Exported to—	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
France	2,567,959	$132,994	667,929	$43,555	2,904,976	$226,299
United Kingdom	19,822,723	902,192	204,644	11,072	147,684	10,327
Canada	8,219,641	502,505	9,084,717	585,342	7,328,927	667,477
Panama	4,012,459	165,524	4,168,834	209,190	4,205,913	295,879
Cuba	3,157,320	185,348	5,825,019	372,752	8,339,548	724,031
Dominican Republic	1,392,682	69,226	3,502,075	194,868	3,277,850	278,072
Mexico	17,562,836	791,518	24,780,334	1,365,059	27,394,799	2,299,176
Haiti	6,824,706	378,062	7,249,054	420,732	7,627,012	736,143
Argentina	819,544	59,159	1,189,986	94,339	943,325	84,558
Colombia	333,402	14,844	287,432	14,413	149,979	11,250
Ecuador	929,484	48,070	718,582	46,633	1,134,602	117,457
Peru	194,541	10,269	267,816	13,408	742,042	66,794
China	121,306	7,088	1,510,173	66,757	1,176,059	71,086
Japan	46,977	2,582	112,608	7,265	27,833	2,592
Philippines	2,788,946	121,385	3,561,117	191,523	2,941,585	196,734
All other	6,754,160	318,511	9,918,259	532,208	14,384,623	1,106,579
Total	75,548,686	3,709,277	73,048,579	4,169,116	82,726,757	6,894,454

Exported to—	1918 [2]		1919 [2]		1920 (9 months). [2]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Austria-Hungary			1,838,929	$181,463		
Belgium	19,840,731	$1,634,998	28,792,281	2,649,710		
Denmark	10,020	691	2,746,928	292,025		
France	6,475,636	536,566	4,736,864	459,020		
Netherlands			1,951,816	228,649		
Norway	67,285	6,731	3,262,448	315,855		
Russia (Europe)	175,840	21,990	1,871,920	166,377		
Sweden	230	22	1,476,525	142,383		
United Kingdom	90,251	8,142	20,587,062	1,749,303		
Canada	7,504,520	762,663	6,207,499	710,536		
Panama	2,849,464	231,057	2,898,677	248,290		
Mexico	47,453,184	4,586,169	36,779,857	3,638,125		
Cuba	6,984,038	642,335	13,168,176	1,288,468		
Dominican Republic	4,844,310	462,749	5,434,223	592,495		
Haiti	7,098,598	748,792	6,266,604	729,749		
Argentina	624,106	53,047	1,445,148	133,122		
China	1,016,314	86,522	1,716,436	145,734		
Philippines	1,511,105	129,301	2,219,153	207,409		
All other	10,437,991	960,060	14,349,059	1,357,383		
Total	116,986,623	10,871,335	157,749,605	15,266,696	99,687,279	$10,800,635

[1] Listed as Dominican Republic beginning with 1914.

[2] Calendar year.

Castile soap, prices (wholesale), per pound, spot, New York Market.

[From Oil, Paint and Drug Reporter.]

Kind or grade.	1912	1913	1914	1915	1916	1917	1918	1919	1920
Green, pure:	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	8 -10	9½-10	8½- 9½	10-12	10-12	14 -15	17-18	17 -18	14½-15
April	9 -10	9½-10	8½- 9½	10-12	11-12½	14½-15½	17-18	17 -18	14½-15
July	9 -10	9½-10	8½- 9½	10-12	11-12½	16	17-18	17 -18	14½-15
October	9 -10	9¼-10	11 -12	10-12	11-12½	17 -18	17-18	14½-15	14½-15
Green, ordinary:									
January	6½- 8	6½- 8	6½- 8	8-10	8-10	10 -11	14-16	14 -16	14 -16
April	6½- 8	6½- 8	6½- 8	8-10	8-10	10 - 11	14-16	14 -16	14 -16
July	6½- 8	6½- 8	6½- 8	8-10	8-10	11 -12	14-16	14 -16	14 -16
October	6½- 8	6½- 8	8 -10	8-10	8-10	12 -13	14-16	14 -16	14 -16
Marseilles:									
January	8 -10	8 -10	8 -10	11-12	11-12	14 -15	18-19	18 -19	18 -19
April	8 -10	8 -10	8 -10	11-12	11-12	15 -17	18-19	18 -19	18 -19
July	8 -10	8 -10	8 -10	11-12	11-12	17 -18	18 19	18 -19	18 -19
October	8 -10	8 -10	10 -12	11-12	11-12	18 -19	18-19	18 -19	18 -19
Mottled, pure:									
January	7½-10	7½-11½	7½- 9	10-12	10-12	.....	15-16½	15 -16½	15 -16½
April	7½- 11	7½-11½	7½- 9	10-12	11-13½	12 -12½	15-16½	15 - 16½	15 -16½
July	7½-11	7½-11½	7½- 9	10-12	11-13½	13 -14	15-16½	15 -16½	15 -16½
October	7½-11	7½-11½	10 -11	10-12	11-13½	16 -16½	15-16½	15 -16½	15 -16½
Mottled ordinary:									
January	7-10	6½-7	6½-7	8-10	8-10	.....	12-13	12-13	12-13
April	6-7	6½-7	6½-7	8-10	8-10	9-10	12-13	12-13	12-13
July	6-7	6½-7	6½-7	8-10	8-10	10-11	12-13	12-13	12-13
October	6-7	6½-7	8 -9	8-10	8-10	11-12	12-13	12-13	12-13
White pure:									
January	11½-12	12-12½	11½-12½	11½-13½	13-15	[1]15½-16½	35-40	75-80	36-37
April	11½-11½	12-12½	11½-12½	11½-13½	15	[1] 25	35-40	75-80	32-40
July	11½-11½	12-12½	11½-12½	12½-13½	15	[1] 27-29	75-80	75-80	32-40
October	11½-11½	12-12½	16	12½-13½	15	26-30	75-80	36-37	30-38

[1] Nominal.

Soaps—Finished products.

[From Prices of Soaps and Glycerin, by H. L. Trumbull, War Industries Board Price Bulletin No. 49.]

	Yellow rosin laundry soap.		White laundry soap.		White floating soap.		Toilet soap, average prices 2 leading brands, Chicago, gross.
	Lenox, f. o. b. Cincinnati, box of 100 9-ounce cakes.	Octagon, eastern market, box of 100 10-ounce cakes.	Crystal white, Kansas City, Kans., 100 bars to box.	P. & G. white naphtha, Cincinnati, box of 100 11-ounce cakes.	Ivory, f. o. b. Cincinnati, box of 100 10-ounce cakes.	Flotilla, Chicago, per 100 5.5-ounce cakes.	
1913	3.0800	3.5250	3.1125	3.9000	6.7500	3.7500	7.8900
Quarters:							
First	3.0000	3.5250	3.0750	3.9000	6.7500	3.7500	7.8900
Second	3.0000	3.5250	3.0750	3.9000	6.7500	3.7500	7.8900
Third	3.1333	3.5250	3.0750	3.9000	6.7500	3.7000	7.8900
Fourth	3.2000	3.5250	3.2250	3.9000	6.7500	3.7500	7.8900
1914	3,0500	3,5250	3.1271	3.9000	6.7500	3.7500	7.8900
Quarters:							
First	3.0500	3.5250	3.3000	3.9000	6.7500	3.7500	7.8900
Second	3.0500	3.5250	3.0750	3.9000	6.7500	3.7500	7.8900
Third	3.0500	3.5250	3.0750	3.9000	6.7500	3.7500	7.8900
Fourth	3.0500	3.5250	3.0583	3.9000	6.7500	3.7500	7.8900
1915	3.0500	3.5250	3.0250	3.9000	6.7500	3.7500	7.8900
Quarters:							
First	3.0500	3.5250	3.0250	3.9000	6.7500	3.7500	7.8900
Second	3.0500	3.5250	3.0250	3.9000	6.7500	3.7500	7.8900
Third	3.0500	3.5250	3.0250	3.9000	6.7500	3.7500	7.8900
Fourth	3.0500	3.5250	3.0250	3.9000	6.7500	3.7500	7.8900
1916	3.2542	3.5667	3.1863	3.9771	6.8125	3.7917	7.9787
Quarters:							
First	3.1500	3.5250	3.0417	3.9000	6.7500	3.7500	7.8900
Second	3.1500	3.5250	3.1383	3.9000	6.7500	3.7500	7.8900
Third	3.2166	3.5250	3.2650	3.9000	6.7500	3.7500	7.8900
Fourth	3.5000	3.6917	3.3000	4.2082	7.0000	3.9167	8.2450

Soaps—Finished products—Continued.

	Yellow rosin laundry soap.		White laundry soap.		White floating soap.		Toilet soap, average prices 2 leading brands, Chicago, gross.
	Lenox, f. o. b. Cincinnati, box of 100 9-ounce cakes.	Octagon, eastern market, box of 100 10-ounce cakes.	Crystal white, Kansas City, Kans., 100 bars to box.	P. & G. white naphtha, Cincinnati, box of 100 11-ounce cakes.	Ivory, f. o. b. Cincinnati, box of 100 10-ounce cakes.	Flotilla, Chicago, per 100 5.5-ounce cakes.	
1917	4.3332	4.5667	3.7500	5.1508	8.3625	4.7125	9.5000
Quarters:							
First	3.5000	3.8250	3.3000	4.2500	7.0000	4.0000	8.0200
Second	4.3250	4.4583	3.7500	5.0200	8.4666	4.5000	9.6600
Third	4.7500	5.0583	3.9000	5.6833	8.9667	5.1167	10.2783
Fourth	4.7500	4.9250	4.0500	5.6500	9.0166	5.2333	10.0416
1918	5.1292	5.7542	5.1208	6.2854	9.9125	5.5042	11.7241
Quarters:							
First	4.8166	5.1083	4.6500	5.9666	9.3333	5.3500	10.2533
Second	5.0000	5.5250	5.2500	6.1000	9.6666	5.3833	11.4533
Third	5.0500	5.9250	5.3083	6.3250	9.8500	5.6000	12.4850
Fourth	5.6500	6.4583	5.2750	6.7500	10.8000	5.6833	12.6750

Soap—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	8	Soap, hard and soft, all of which are not otherwise specially enumerated or provided for in this act, and castile soap.	20 per cent ad valorem.
1883	9	Fancy, perfumed, and all descriptions of toilet soap	15 cents per pound.
1890	79	Castile soap	1½ cents per pound.
		Fancy, perfumed, and all descriptions of toilet soap	15 cents per pound.
		All other soaps, not specially provided for in this act	20 per cent ad valorem.
1894	63	Castile soap	Do.
		Fancy, perfumed, and all descriptions of toilet and medicinal or medicated soap.	35 per cent ad valorem.
		All other soaps, not specially provided for in this act	10 per cent ad valorem.
1897	72	Castile soap	1¼ cents per pound.
		Fancy, perfumed, and all descriptions of toilet soap, including so-called medicinal or medicated soaps.	15 cents per pound.
		All other soaps, not specially provided for in this act	20 per cent ad valorem.
1909	69	Castile soap	1¼ cents per pound.
		Medicinal or medicated soaps	20 cents per pound.
		Fancy or perfumed toilet soaps	50 per cent ad valorem.
		All other soaps, not specially provided for in this section	20 per cent ad valorem.
1913	66	Perfumed toilet soaps	30 per cent ad valorem.
		Medicinal soaps	20 per cent ad valorem.
		Castile soap and unperfumed toilet soap	10 per cent ad valorem.
		All other soaps and soap powder, not specially provided for in this section.	5 per cent ad valorem.
		In the acts from 1883 to 1897, inclusive, there was a provision for "fancy, perfumed, and all descriptions of toilet soap." In 1909 the word "or" was inserted between "fancy" and "perfumed," and the words "and all descriptions of" omitted. In 1913 the words "fancy or" were eliminated, and separate provision made for unperfumed toilet soap as well as for perfumed toilet soap.	
		"Medicinal or medicated" soap was also separately enumerated in the acts of 1894, 1897, and 1909, but only "medicinal" was retained in the act of 1913.	

COURT AND TREASURY DECISIONS.

"Soap" embraces liquid as well as solid combinations. Tetrapol soap, containing 17 per cent of alcohol in the mixture, was held dutiable under the provision for "other soaps" n. s. p. f., in paragraph 69 of the act of 1909. (United States *v.* Farbenfabriken of Elberfeld Co., 3 Ct. Cust. Appls., 358.) Soap of the same name, but apparently having no alcohol, was likewise classified under the act of 1897. (G. A. 6902, T. D. 29724.)

The phrase "fancy toilet soap," in paragraph 69 of the act of 1909, was held to include Pears' unscented soap. (Downing *v.* United States, 1 Ct. Cust. Appls., 500.)

Medicinal soap has been defined to be soap which has in its composition substances claimed to be beneficial to the human skin, or which are to be used on the human body for remedial purposes. (Parks *v.* United States, 66 Fed., 731; G. A. 2056, T. D. 13951; G. A. 2616, T. D. 15039; G. A. 5531, T. D. 24901; Abstract 37688.)

Tooth soap was held to come within the provision in the act of 1897 for "all descriptions of toilet soap" as more specific than the provision for "preparations used as applications to the * * * teeth * * * dentifrices * * * not specially provided for." (United States *v.* Park, 155 Fed., 143.)

Merchandise invoiced as antiseptic bath tablets was held properly classified as toilet preparations under paragraph 48 of the act of 1913 rather than as medicinal soap under paragraph 66. (Abstracts 36895 of 1914 and 41376 of 1917.)

Consumption of fats and oils by the soap industry.[1]

Products consumed.	1912	1914	1916	1917
Vegetable:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Chinese vegetable tallow	2,013,000	3,485,000	5,273,000	6,471,000
Chinese nut oil			118,000	115,000
Coconut oil	78,816,000	77,959,000	111,084,000	168,602,000
Corn oil	9,922,000	11,368,000	12,821,000	15,997,000
Cottonseed oil	132,312,000	119,254,000	194,916,000	126,390,000
Linseed oil	1,390,000	1,034,000	803,000	1,006,000
Olive oil	690,000	748,000	1,184,000	1,731,000
Palm oil	7,546,000	71,896,000	14,938,000	27,345,000
Palm kernel oil	20,579,000	31,376,000	5,804,000	4,762,000
Peanut oil	31,000	76,000	1,181,000	15,126,000
Rapeseed oil	6,532,000	6,664,000	7,224,000	5,972,000
Sesame oil	1,110,000	11,000	8,000	5,000
Shea nut oil			1,058,000	2,487,000
Soy bean oil	1,182,000	4,499,000	57,373,000	124,058,000
Miscellaneous oils	9,097,000	6,637,000	7,020,000	9,692,000
Total	271,120,000	335,007,000	420,805,000	509,705,000
Animal and fish:				
Bone grease	17,526,000	16,832,000	19,535,000	37,032,000
Garbage grease	12,619,000	13,627,000	28,719,000	63,118,000
Herring oil	56,000	10,339,000	2,705,000	4,104,000
Lard	8,469,000	10,484,000	8,294,000	7,481,000
Menhaden oil	116,000	882,000	330,000	2,279,000
Neats-foot oil and stock	29,000	77,000	329,000	118,000
Recovered grease	2,858,000	10,627,000	8,531,000	12,680,000
Sperm oil	9,000	7,000	14,000	17,000
Tallow	238,685,000	270,713,000	338,931,000	362,297,000
Tankage grease	28,566,000	31,822,000	35,769,000	38,303,000
Whale oil	9,927,000	4,023,000	8,126,000	5,732,000
Miscellaneous oils	4,639,000	10,909,000	11,130,000	9,490,000
Total	323,499,000	380,342,000	462,413,000	542,651,000

[1] From "The Production and Conservation of Fats and Oils in the United States," Dept. of Agr. Bull. No. 769 and supplement.

Consumption of fats and oils by the soap industry—Continued.

Products consumed.	1912	1914	1916	1917
Derivatives:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Acidulated soap stock	20,135,000	32,075,000	20,473,000	25,086,000
Cottonseed foots	77,975,000	88,667,000	103,868,000	107,070,000
Cottonseed foots (distilled)	11,152,000	19,474,000	8,410,000	8,872,000
Fatty acids	16,735,000	20,896,000	33,720,000	35,050,000
Fatty acids (distilled)	12,765,000	14,946,000	28,195,000	39,465,000
Crease stearin	1,461,000	944,000	5,144,000	19,146,000
Lard oil	1,134,000	1,265,000	2,143,000	2,148,000
Olive oil foots	5,457,000	7,298,000	9,411,000	10,500,000
Red oil	8,723,000	10,275,000	10,230,000	12,812,000
Miscellaneous stock	25,000,000	25,000,000	25,000,000	25,000,000
Total	180,537,000	220,840,000	246,594,000	285,149,000
Grand total	775,156,000	936,189,000	1,129,812,000	1,337,505,000

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPH 67 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

SODIUM COMPOUNDS

(All of paragraphs 67 and 605)

Paragraph 64:
- **Potassium prussiates, red or yellow**
- **Potassium nitrate, refined**
- **Potassium chromate and bichromate**

Paragraph 387:
- **Chromic acid**
- **Silicic acid**

Paragraph 440:
- **Calcium nitrate**

Paragraph 449:
- **Chromium hydroxide**

Paragraph 580:
- **Potassium nitrate, crude**
- **Potassium cyanide**

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U.S. Tariff Com.
6-4-26

PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the Free List, the article is discussed under the dutiable paragraph which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and Index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of C. R. DeLong and Dr. Grinnell Jones, of the chemical division of the Commission's staff and of others.

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BORATE OF SODA OR BORAX.

[See par. 1.]

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SODIUM ARSENATE.

[Par. 605, act o 1913. Free.]

General Information.

Description.—Arseniate of soda or correctly sodium arsenate is a white, solid substance. It is soluble in water and very poisonous. In England it is sometimes called "dung salt."

Uses.—Its principal use is in the preparation of insecticides, especially in the manufacture of arsenate of lead, and to a limited extent in medicine.

Manufacture.—Arseniate of soda is prepared from white arsenic, arsenious oxide.

One process consists in treating the oxide with soda ash, drying the mixture and heating it with potassium nitrate in a reverberatory furnace. The product is dissolved in water and purified by crystallization.

Another method is to heat white arsenic directly with sodium nitrate. The product is leached with water and the sodium arseniate obtained by crystallization.

Domestic production.—Figures for the domestic production are not available.

Imports.—Some arseniate of soda is imported. The largest imports shown are for the fiscal year ending June 30, 1913, when 1,267,998 pounds, valued at $55,941, were imported. This is more than double the amount imported during any other year. In 1914, 228,270 pounds were imported, all of which came from England. During the war the imports continued to decrease and in 1918 amounted to only 35 pounds.

Exports.—No exports of arseniate of soda are shown in Commerce and Navigation but some is probably shipped to Canada.

Foreign production.—Figures for the foreign production are not available.

Tariff history.—Arseniate of soda is not mentioned in any of the tariff acts previous to the act of 1897 when a duty of 1¼ cents per pound was placed on it. In the act of 1909 the duty was reduced to 1 cent per pound and in 1913 arseniate of soda was put on the free list.

Sodium arsenate—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910 [1]	1¼ cents per pound.	16,426	$367	$205	$0.022	55.95
1910 [2]	1 cent per pound..	468,296	14,001	4,682	.030	33.45
1911	....do....	168,442	5,199	1,684	.031	32.40
1912	....do....	356,491	11,195	3,564	.031	31.84
1913	....do....	1,267,998	55,941	12,679	.044	22.67
1914 [3]	Free	228,270	8,267		.036	
1915	....do....	85,850	3,188		.037	
1916	....do....	36,176	3,436		.094	
1917	....do....	23,296	2,404		.103	
1918	....do....	35	88		2.514	
1918 [4]	....do....	35	88		2.514	
1919 [4]	....do....					
1920 [5]	....do....	11,448	1,118		.098	

[1] From July 1 to Aug. 5, 1909.
[2] From Aug. 6, 1909, to June 30, 1910.
[3] From Oct. 4, 1913, to June 30, 1914. No imports during year prior to Oct. 4.
[4] Calendar years.
[5] First 6 months.

Arseniate of soda—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Not specifically mentioned.....	
1890	.....	....do.....	
1894	.....	....do.....	
1897	78	Arsenate of soda.....	1¼ cents per pound.
1909	75	....do.....	1 cent per pound.
1913	605	....do.....	Free.

SODIUM BENZOATE.

[This sodium salt is a coal-tar compound. It is provided for in H. R. 8078. See following reports of Tariff Commission. Dyes and Other Coal-Tar Chemicals. Census of Dyes and Coal-Tar Chemicals, 1917, 1918, and 1919.]

SODIUM BICARBONATE.

[Par. 67, act of 1913. One-fourth cent per pound.]

SUMMARY.

Description.—Bicarbonate of soda or acid sodium carbonate is the mildest of the alkalies. It contains about 36.9 per cent of alkali (Na_2O). In the pure form it is the common baking soda. Sodium bicarbonate is the cheapest and most convenient form of storing carbon dioxide. It is used in the manufacture of baking powders, seidlitz powders, effervescing drinks, in charging fire extinguishers, and for many household purposes.

Domestic production.—The production of sodium bicarbonate has increased from 90,169 short tons valued at $1,439,014 in 1914 to 174,212 short tons valued at $5,292,374 in 1917. The 1919 output was 134,962 short tons valued at $3,486,635. This domestic production supplies practically all of our consumption.

Salt, lime, ammonia, and coal are the raw materials required for the manufacture of bicarbonate of soda, all of which are available in large quantity in this country. The ammonia is recovered and used repeatedly.

The plants manufacturing bicarbonate of soda are located near deposits of salt, the basic raw material. Refined bicarbonate of soda for baking purposes is produced at Syracuse, N. Y.; Saltville, Va.; and Wyandotte, Mich. At these plants it is one of the products of the Solvay ammonia-soda process, the other products being soda-ash and caustic soda. A small quantity is produced from the waters of Owens Lake, Calif.

The production of bicarbonate of soda involves large-scale continuous operation, the materials being handled principally by labor-saving mechanical devices. A plant for producing bicarbonate of soda requires a large initial outlay of capital and a highly developed organization.

Imports.—The imports of sodium bicarbonate have been small compared with our production. The maximum imports since 1910 were in 1916, amounting to 129,414 pounds, valued at $2,867. In 1917 they fell off to 34,742 pounds valued at $1,821.

Prices.—The price of bicarbonate of soda has about doubled since the outbreak of the war. This is not as great an increase as the other alkalies have undergone, probably due to the fact that bicarbonate of soda is not as important industrially as the other alkalies.

Tariff history.—Bicarbonate of soda has paid a specific duty varying from 1½ cents per pound by the act of 1883 to ¼ cent per pound by the act of 1913.

Sodium bicarbonate—Summary table.

[Short tons of 2,000 pounds.]

Year.	Domestic production, calendar years.	Imports for consumption, fiscal years.	Year.	Domestic production, calendar years.	Imports for consumption, fiscal years.
1910		73	1916	115,117	65
1911		43	1917	119,177	17
1912		55	1918	118,535	15
1913		40	1919	134,962	6
1914	90,169	44	1920		6¾
1915		49			

Domestic exports not shown in Commerce and Navigation.

Year.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
				Per cent.
1910 [1]	$707	$114	$0.046	16.16
1910 [2]	3,765	820	.029	21.78
1911	2,634	532	.031	20.22
1912	3,193	687	.029	21.54
1913	2,238	504	.028	22.54
1914 [3]	1,695	156	.027	9.25
1915	2,584	245	.026	9.51
1916	2,867	323	.022	11.29
1917	1,821	87	.052	4.77
1918	944	74	.032	7.80
1919	711	32	.056	4.50
1920	3,514	33	.263	.95

[1] From July 1 to Aug. 5, 1909.
[2] From Aug. 6, 1909, to June 30, 1910.
[3] From Oct. 4, 1913, to June 30, 1914. In the period from July 1 to Oct. 3, 1913, there were imports valued at $629, equivalent ad valorem of 26.02 per cent, and duties of $163.

General Information.

Description and uses.—Bicarbonate of soda, or acid sodium carbonate, is the mildest of the alkalies. It is composed of 36.9 per cent of sodium oxide (Na_2O), 52.4 per cent of carbon dioxide (CO_2) and 10.7 per cent of water (H_2O). It is a white opaque powder which is soluble in water. In the pure form bicarbonate of soda is the common baking soda. When heated, either in the dry form or in solution, sodium bicarbonate loses half of its carbon dioxide with the formation of soda ash. When treated with an acid it loses all of its carbon dioxide; it is this property of evolving its carbon dioxide that gives bicarbonate of soda its use for industrial and household purposes. Sodium bicarbonate is the cheapest form of storing carbon dioxide and it is also the most convenient.

It is used in the manufacture of baking powders, Seidlitz powders, effervescing drinks, and is used in medicine as a remedy for acidity of the stomach. It is also used in the household for destroying the acidity of sour milk and other articles of food. A very pure product is demanded for the above household and medicinal purposes. A product of less purity is used for producing carbonic acid for the

carbonating of waters, for charging fire extinguishers, and for the prevention of timber mold.

Mixtures of sodium bicarbonate and sodium carbonate (soda ash) are sold as "modified or neutral sodas." These mixtures are usually used for cleaning purposes.

Raw materials.—Salt in the form of brine, lime, ammonia, and coal are the necessary materials required for the production of sodium bicarbonate by the "ammonia-soda" process. The ammonia is used over and over again so that it is only necessary to supply the losses in process which are relatively small. The lime is usually burnt at the plant, so that the carbon dioxide evolved is available for use in the "ammonia-soda" process. The lime is used for the regeneration of the ammonia and for the manufacture of caustic soda which is usually produced in conjunction with an "ammonia-soda" plant. The brine should be of a good grade and particularly should not contain an appreciable amount of magnesium, which will cause trouble in the process. All of the raw materials necessary for the manufacture of sodium bicarbonate are available in large quantities in the United States. The industry is therefore independent of any foreign country so far as the raw materials are concerned.

Process of manufacture.—The basic raw material salt is first dissolved to form a concentrated brine solution. For the economical operation of this process the factories are located where the salt can be pumped as a saturated brine from the salt beds in the immediate neighborhood. This brine solution is then saturated with ammonia gas. The ammoniacal brine is then treated with carbon dioxide in a high tower. The main reaction occurs in these towers with the formation of bicarbonate of soda, which separates out as it is insoluble in the solution of ammonium chloride which is produced simultaneously. The precipitated sodium bicarbonate works its way down the tower and is finally drawn off at the bottom in the form of a white milky liquid containing the bicarbonate in suspension. The bicarbonate of soda is separated from the mother liquor by filtration and is purified by washing. The ammonia is recovered from the mother liquor and wash waters by treating with lime.

The crude bicarbonate of soda thus produced ordinarily contains too much ammonia to be used as baking soda or in the manufacture of baking powders. It is found that drying this crude bicarbonate of soda to remove moisture does not remove the ammonia and if heated sufficiently to remove the ammonia the bicarbonate is partially decomposed into soda ash. The crude bicarbonate is, therefore, converted first into soda ash by calcination. (See Tariff Information Survey on Sodium Carbonates.) The soda ash is then dissolved in water and carbonic acid gas is passed through the solution, thus producing a refined bicarbonate of soda.

Before the introduction of the "ammonia-soda" process, sodium bicarbonate was made from soda crystals by treating them with carbon dioxide in suitable apparatus. This process is not in general use in this country.

Bicarbonate of soda is manufactured from the waters of Owens Lake, Calif., by passing carbonic acid gas through the water in a tower. Operations are carried on only during the season from April 1 to November 1. During the winter months the alkali separates out in the lake in the form of trona ($Na_2CO_3 . NaHCO_3 . 2H_2O$) and so

reduces the alkali content of the water that it is not suitable for the manufacture of bicarbonate of soda.

History of the industry.—The history of the manufacture of bicarbonate of soda practically parallels that of soda ash as the two products are very closely allied. (See the report on Soda Ash.) The development of the baking powder industry using sodium bicarbonate as the active constituent has been the greatest in the United States, as there has been very little development of this industry in Europe. Even before bicarbonate of soda was made in this country, baking powders were manufactured in the United States from sodium bicarbonate imported from England.

Bicarbonate of soda—Production in United States.

[From Federal Census.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1899	68,856	$1,332,765	1909	82,800	$1,515,045
1904	68,867	1,135,610	1914	90,169	1,439,014

[From Geological Survey, Sodium Salts.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1916	115,117	$2,303,540	1918	118,535	$3,293,153
1917	119,177	4,029,499	1919	134,962	3,486,635

Sodium bicarbonate—Exports of the United Kingdom.

Quantities are in short tons of 2,000 pounds. Table is taken from the official report of the United Kingdom and the quantities and values were converted into United States units.]

Country.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Spain	1,671	$37,673	1,822	$41,293	3,029	$68,581
Italy	2,024	45,030	2,149	46,456	2,028	44,967
Japan	3,620	84,775	4,619	106,235	4,740	109,855
Argentina	1,256	27,250	1,113	24,558	2,480	39,366
Canada	2,574	46,470	3,259	55,954	2,828	50,237
Total foreign	12,718	292,471	14,005	320,139	17,406	374,740
Total British	12,960	282,418	15,048	316,718	15,032	318,820
Grand total	25,678	574,889	29,053	637,857	32,438	693,561

Sodium bicarbonate—Exports of the United Kingdom—Continued.
[Short tons of 2,000 pounds.]

Country.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Spain	349	$8,019	20	$671	8	$506
Italy	1,961	43,264	1,927	42,500	2,468	56,110
Japan	4,764	108,721	4,885	114,249	3,678	86,031
Argentina	2,263	36,811	1,258	19,644	834	14,471
Canada	2,777	49,443	2,894	49,706	2,730	54,188
Total foreign	13,840	226,349	13,345	294,004	13,625	312,324
Total British	14,134	304,928	15,170	326,411	17,506	393,908
Grand total	27,974	601,277	28,515	620,415	31,131	706,232

Country.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Spain	16	$905	15	$1,192	.....	.....
Italy	4,222	187,759	2,331	91,826	2,274	$175,953
Japan	5,069	124,570	3,153	80,253	2,499	79,728
Argentina	824	16,943	1,439	49,147	621	18,225
Canada	2,941	67,832	2,106	36,562	1,039	23,481
Total foreign	18,735	570,388	13,576	445,426	10,095	501,741
Total British	18,315	481,452	14,403	404,440	14,480	507,732
Grand total	37,050	1,051,839	27,979	849,866	24,575	1,009,473

Bicarbonate of soda, etc., containing 50 per cent. or more of bicarbonate of soda—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	¾ cent per pound	136,037	$4,274	$1,020	$0.031	23.87
1908	....do	85,344	2,555	640	.030	25.05
1909	....do	121,762	4,821	913	.040	18.94
1910	....do	15,235	707	114	.046	16.16
1910	⅝ cent per pound	131,224	3,765	820	.029	21.78
1911	....do	85,202	2,634	532	.031	20.22
1912	....do	110,015	3,193	687	.029	21.54
1913	....do	80,699	2,238	504	.028	22.54
1914	....do	26,184	629	163	.024	26.02
1914	½ cent per pound	62,688	1,695	156	.027	9.25
1915	....do	98,318	2,584	245	.026	9.51
1916	....do	129,414	2,867	323	.022	11.29
1917	....do	34,742	1,821	86	.052	4.77
1918	....do	29,444	944	73	.032	7.80
1919	....do	12,665	711	32	.056	4.50
1920	....do	13,353	3,514	33	.263	.95

Bicarbonate of soda (American)—Prices (wholesale) per 100 pounds f. o. b. works.
[From Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
1912	$1.00–$1.10	$1.00–$1.10	$1.00–$1.10	$1.00–$1.10
1913	1.00– 1.10	1.00– 1.10	1.00– 1.10	1.00– 1.10
1914	1.00– 1.10	1.00– 1.10	1.00– 1.10	1.00– 1.10
1915	1.00– 1.10	1.00– 1.10	1.00– 1.10	1.00– 1.10
1916	1.20– 1.30	1.65– 1.80	1.65– 1.80	1.65– 1.75
1917	1.75– 1.90	1.75– 2.00	2.25– 2.50	2.60– 2.75
1918	2.25– 2.90	2.60	3.00– 3.50	3.00– 3.50
1919	3.00– 4.00	2.75– 4.00	2.35– 2.85	2.40– 2.50
1920	2.40– 2.50	2.45– 2.70	2.45– 3.00	2 90– 3.15

Bicarbonate of soda (English), prices (wholesale), spot, New York, per pound.

[From Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
	Cents.	*Cents.*	*Cents.*	*Cents.*
1912	2½–3	2½–3	2½–3	2½–3
1913	2½–3	2½–3	2½–3	2½–3
1914	2½–3	2½–3	2½–3	2½–3
1915	3½–3¾	3½–3¾	3½–3¾	3½–3¾
1916	3½–3¾	3½–3¾	3½–3¾	3½–3¾
1917	3½–3¾			

Bicarbonate of soda—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	A	Bicarbonate of, or supercarbonate of, and saleratus, calcined or pearl ash.	1½ cents per pound.
1890	80	Bicarbonate of soda or supercarbonate of soda or saleratus	1 cent per pound.
1894	64	Soda: Bicarbonate of soda or supercarbonate of soda or saleratus	½ cent per pound.
1897	73	Soda: Bicarbonate of soda, or supercarbonate of soda or saleratus, and other alkalies containing 50-per centum or more of bicarbonate of soda.	¾ cent per pound.
1909	70	Bicarbonate of soda, or supercarbonate of soda, or saleratus, and other alkalies containing 50 per centum or more of bicarbonate of soda.	⅝ cent per pound.
1913	67	Soda: Bicarbonate of, or supercarbonate of, or saleratus, and other alkalies containing 50 per centum or more of bicarbonate of soda.	¼ cent per pound.

COURT AND TREASURY DECISIONS.

So-called industrial bicarbonate of soda, found to have the character of the bicarbonate of soda made in the United States by the ammonia process, was held dutiable as bicarbonate of soda under the act of 1894.—G. A. 3329 (T. D. 16810).

BORATE OF SODA OR BORAX REFINED.

[Par. 67, act of 1913, ½ cent per pound. See paragraph 1.]

SODIUM CARBONATES—SODA ASH, SAL SODA, SODA CRYSTALS

[Par. 67 and 605, act of 1913.]

SUMMARY.

Description.—Soda-ash or calcined sodium carbonate is the most important industrial alkali. There are two commercial grades containing 48 and 58 per cent of alkali (Na_2O). The largest use of soda ash is in the manufacture of glass, soap, wood pulp and paper, and caustic soda.

Domestic production.—The domestic production has increased from 740,455 short tons in 1909 to 1,390,625 short tons in 1917. Our production supplies nearly all of the domestic consumption.

By far the larger part of soda ash produced in this country is manufactured by the Solvay "ammonia-soda" process, which also produces soda ash and caustic soda. There is a small production of soda ash by the Hargraves-Bird electrolytic process. In European countries the bulk of soda ash is made by this process, but there is also some produced by the old Le Blanc process. Since 1900 over 90 per cent of the world's production has been made by the Solvay process.

Exports of soda ash are not shown separately in Commerce and Navigation until the 1918 fiscal year, when 198,752,457 pounds, valued at $6,074,879, were exported. In addition there was exported for the same period 14,076,264 pounds of sal soda or washing sodas, valued at $205,489.

The raw material necessary for the manufacture of soda ash is sodium bicarbonate, which is made from salt by the ammonia-soda process.

The plants manufacturing soda ash are located near salt deposits. Soda ash is produced at Syracuse, N. Y.; Saltville, Va.; Wyandotte and Detroit, Mich.; Barberton and Painesville, Ohio; and Hutchinson, Kans.

The production of soda ash involves large-scale continuous operation. The materials are handled principally by labor-saving mechanical devices. A plant to manufacture soda ash requires a large initial expenditure and a highly developed organization. It may be stated that it costs $1,250,000 to build a plant for the manufacture of 100 tons of soda ash per day.

Foreign production.—Prior to the war, England was the exporting country of first importance, controlling the markets of South American countries. The exports of the United Kingdom are shown on

later pages. Germany also exported considerable soda ash, and the figures of her exports by countries are found in following pages.

Imports.—Our imports of soda ash, since 1910, have been between 500 and 2,000 tons, which is small compared with our production.

Prices.—The price of soda ash at the beginning of 1918 was about four times the normal prewar prices.

Tariff history.—Soda ash was dutiable at one-fourth cent per pound from the act of 1883 until the act of 1897, when the duty was raised to three-eighths of a cent. The act of 1909 restored the former duty of one-fourth cent. The acts of 1913 placed soda ash on the free list.

Soda ash—Summary table.

Years.	Domestic production (calendar year).	Fiscal years.	
		Imports for consumption.	Domestic exports.
		Short tons.	
1910		2,495	
1911		1,939	
1912		1,453	
1913		1,550	
1914	935,305	1,114	
1915		1,064	
1916	1,193,183	439	
1917	1,390,625	524	
1918	1,390,628	757	99,376
1919	981,054	203	95,932
1920			57,999

Years.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
				Per cent.
1910 [1]	$6,208	$2,106	$0.011	33.9
1910 [2]	49,054	11,070	.011	22.5
1911	43,365	9,695	.011	22.3
1912	33,459	7,264	.011	21.7
1913	35,461	7,752	.011	21.8
1914 [3]	2,949	701	.011	23.7
1915	29,022	.....	.014	.....
1916	20,718	(4)	(4)	(4)
1917	29,239	.....	.028	.....
1918	55,331	.....	.037	.....
1919	10,509	.....	.026	.....

[1] From July 1 to Aug. 5, 1909.
[2] From Aug. 6, 1909, to June 30, 1910.
[3] From July 1 to Oct. 4, 1913, under the act of 1909.
[4] Placed on free list by act of Oct. 3, 1913.

General Information.

SODA ASH.

Description.—Soda ash or calcined sodium carbonate is the most important industrial alkali and probably ranks next to sulphuric acid as the most important chemical substance. It is not as strong an alkali as caustic soda but it is cheaper, easier to handle and ship, and is ordinarily used in preference to caustic soda wherever it is suitable. The commercial product is usually a white fine powder, which at times may have a slight yellow color due to impurities such

as oxide of iron. Chemically pure sodium carbonate contains 58.5 per cent of sodium oxide and 41.5 per cent of carbon dioxide (CO_2). The highest commercial grades approach very closely this composition. The common commercial grades are 58 and 48 per cent based on the actual percentage content of sodium oxide (Na_2O). Soda ash of any desired strength below 58 per cent can be furnished by the manufacturers of soda ash. The lower grades are diluted with salt or sodium sulphate (Glaubers salt) according to the purpose for which they are to be used. The 58 per cent grade is sold as "58 per cent ordinary" and "58 per cent dense;" the only distinction being in the density. The "dense" weighs twice as much per unit of volume as the "ordinary." The "dense" is used where small bulk is desired as in the manufacture of glass.

There is a wide divergence in the methods of stating the strength and purity of soda ash and the other alkalies. The method of stating the purity with the exception of Germany and France, is nominally based on a statement of the per cent of sodium oxide (Na_2O) contained in the soda ash. However, sodium carbonate or soda ash became an article of commerce while chemical science was in its infancy. At an early date a method of computing the composition of soda ash from its chemical analysis was adopted, based on the chemical equivalents generally accepted at that time as being correct. This test was called the "Newcastle test." The advance of chemical science has since proven that this "Newcastle test" was seriously in error, but this old erroneous method has persisted in commercial use. The persistence in England of this erroneous method may be partly ascribed to the conservation of the English business man and partly to the fact that the method overstates the purity of the product. This "Newcastle test" is still generally used in England. At a later date the so-called "New York and Liverpool test" was devised. This "New York and Liverpool test" is even more irrational than the "Newcastle test" and at its time of invention must have been known to be erroneous. This method overstates the purity and quality of the product even more than the Newcastle test which may account for its introduction. This method of stating the purity of soda ash has commonly been used in the export trade of England and thus came into use in the United States. In this country at the present time commercial transactions in soda ash are based on an accurate statement of the per cent of sodium oxide based on modern knowledge of the chemical equivalents. In Germany soda ash is sold on a basis of the percentage content of sodium carbonate (Na_2CO_4), while in France it is sold according to Descroizille's degrees which give the strength of soda ash in terms of the percentage of sulphuric acid (H_2SO_4) which is chemically equivalent to the sodium carbonate present.

On the whole the most rational and desirable basis would seem to be to report and quote the strength of soda ash in terms of the percentage content of "actual alkali" (Na_2O). However, if a definite test is specified and the buyer and seller thoroughly understand the different tests there should be no trouble or confusion.

The following table shows the difference in the values of the common grades of soda ash as calcualted by the different tests:

Actual alkali (sodium oxide Na_2O).	German method (sodium carbonate Na_2CO_3).	Newcastle test (sodium oxide Na_2O).	New York and Liverpool (sodium oxide Na_2O).	French degree (sulphuric acid H_2SO_4).
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
48.0	82.67	48.63	49.54	75.87
58.0	99.16	58.76	59.87	91.68

SAL SODA OR WASHING SODA.

Sal soda or washing soda is a crystalline form of sodium carbonate containing 10 molecules of water (Na_2CO_3—10 H_2O). Although soda crystals if chemically pure only contain 37.08 per cent of sodium carbonate, or 21.71 per cent of sodium oxide, and thus cost more than their equivalent amount of soda ash for package and freight, they are preferred to soda ash in some cases, especially for household washing purposes. The large use of soda crystals in the past may be attributed to the fact that they were very pure and contained no caustic soda. This absence of caustic soda gave them a preference over soda ash for washing wool, fabrics, and household cleaning. The soda ash now produced by the "ammonia-soda" process contain no trace of caustic soda and has practically replaced soda crystals for industrial purposes. The soda crystals, however, have retained their wide use for household purpose, as they dissolve more easily and are easier to handle than soda ash. An English writer of 1879 says, "The greatest part of the trade in crystals is done with foreign countries where heavy import duties upon soda ash give the manufactured product the advantage."

MONOHYDRATED SODIUM CARBONATE.

"Monohydrated sodium carbonate," or crystal carbonate, is another crystalline compound of sodium carbonate containing one molecule of water (Na_2CO_3—H_2O). It has an advantage over the ordinary soda crystals in that it contains a higher percentage of alkali (Na_2O) and is usually purer. In addition it is more readily dissolved in water than the soda crystals because it raises the temperature in the act of solution instead of lowering it, as is the case when soda crystals are dissolved.

"SESQUICARBONATE" OF SODA.

Soda occurs in nature as the "sesquicarbonate" (Na_2CO_3—$NaHCO_3$—$2H_2O$), which is a compound of equivalent amounts of sodium carbonate and sodium bicarbonate with two molecules of water. Extensive deposits of this mineral, known as "natrona," "trona," or "urao," are found in Hungary, Egypt, and the deserts of Africa, Asia, and North and South America. In the United States the waters of three lakes—Albert Lake, Oreg.; Mono and Owens Lakes in California—have been estimated as containing over 118,000,000 tons of sodium carbonate and 27,000,000 tons of sodium bicarbonate.

The development of these natural sodas has been slow for several seasons. It is difficult to separate the sodium alkalis from the other ralts, such as sulphate, chloride, borate, and other impurities. In addition the lands have been tied up with litigation as to ownership. These lakes also contain appreciable amounts of potash salts and the recent development of this source of potash will evidently result in an increased production of soda salts as a by-product.

Pennock in Rep. V. Intern. Congr. Appl. Chem. i, page 668, states the actual production of soda in tons as sodium carbonate from the above lakes to be as follows:

1898	1,263	1901	20,000
1899	5,512	1902	22,000
1900	14,600		

Of this amount three-fourths went into trade as calcined soda ash, one-eighth as bicarbonate of soda and one-eighth as soda crystals.

Important uses.—The largest use for soda ash is in the manufacture of glass, soap, wood pulp and paper, and caustic soda. It is also used in the manufacture of a number of other sodium chemicals. Soda ash is used in the dye and textile industries, in the manufacture of drugs, enamel ware, cleaners, and for water softening, metallurgical operations, and in bottle and dish washing. The soda crystal are used chiefly for washing purposes, especially in the household. There are many other minor uses of soda ash too numerous to mention.

Raw materials.—Practically all of the soda ash manufactured in the United States is made from bicarbonate of soda, which is made from salt by the "ammonia-soda" process. We may therefore consider salt as the basic raw material for the production of the majority of the soda ash manufactured in this country. There is a relatively small quantity of soda ash made from the natural soda deposits of the Western States. This last source of soda ash is of very little consequence in comparison with the production of soda ash by the "ammonia-soda" process.

Process of manufacture.—(A) Le Blanc process. This was the first process to be worked on a large industrial scale for the manufacture of soda ash from salt. It originated in France but has had its greatest development in England.

The salt is first converted into sodium sulphate (salt cake) by the means of sulphuric acid. The sodium sulphate or salt cake is then heated with limestone and coal until the mass is in a semifluid or pasty condition, after which the conversion of the sodium sulphate to sodium carbonate is rapid and practically complete. The sodium carbonate is dissolved from the mass by lixiviation with water. The solution of sodium carbonate is then settled, evaporated and the soda crystals which form are calcined to soda ash. The soda ash produced by this process often had to pass through a repurification process before it was suitable for the manufacture of glass. This repurified soda ash was known as "refined ash."

The Le Blanc process has never become firmly established in the United States, although in 1884 a small Le Blanc plant was erected in Wyoming for transforming the natural sodium sulphate found there into soda ash. This plant operated for only a short time.

(B) The "ammonia-soda" process. This process is used for the production of by far the greater part of the soda ash manufactured

in the United States. As this process is described for the manufacture of bicarbonate of soda the description up to that point will be omitted here. (See Report on Bicarbonate of Soda.) Bicarbonate of soda is converted into soda ash simply by the application of heat. This operation is carried out continually in a revolving furnace. The damp bicarbonate of soda is fed into one end and the finished soda ash comes out at the other end. The carbon dioxide and ammonia driven off during the calcination are recovered and used again to produce more bicarbonate of soda. If the "dense" soda ash is desired the "ordinary" ash is subjected to the direct furnace gases, thus about doubling the weight of the ash per unit volume.

(C) Cryolite process. Thorp, in Outlines of Industrial Chemistry, page 96, describes the cryolite soda process as follows:

> The ground cryolite is mixed with powdered limestone, and calcined at a red heat. Carbon dioxide escapes, and a mixture of calcium flouride, sodium oxide, and sodium aluminate remains. On lixiviating this mixture with water, another sodium aluminate is formed and goes into solution, leaving the calcium flouride as an insoluble residue. The solution of sodium is decomposed, * * *, by passing into it purified lime-kiln gases, or the furnace gases of the calcining operation. Hydrated alumina is precipitated, while sodium carbonate remains in solution. Salsoda may be made by evaporating the solution, and was formerly the chief source of bicarbonate for culinary and medicinal purposes. If carried to complete dryness and calcined, a high grade of soda ash is obtained.

This process was formerly used by one company in this country, but has not been operated for several years.

(D) The Hargreaves-Bird process. This process is based on the electrolytic production of caustic soda from salt. The caustic soda is produced in an atmosphere of carbon dioxide, which immediately converts the caustic soda into sodium carbonate. The solution of sodium carbonate on evaporation yields a monohydrated sodium carbonate, which may be sold as such or they may be calcined, thus producing soda ash.

This process is operated at the present time (January, 1919) by two large paper companies in a total of six paper mills. In the manufacture of soda pulp about 90 per cent of the caustic soda used in the digestion is recovered as soda ash or "black ash." The soda ash produced by the Hargreaves-Bird process is used to supply the loss of alkali and is causticized along with the recovered "black ash." This process is evidently feasible when operated in connection with soda pulp manufacture where equipment for the causticization of large quantities of soda ash is already installed. It is doubtful whether this process is economically feasible for the commercial production of soda ash in competition with the product of the "ammonia-soda" process.

(E) Manufacture of soda crystals. Soda crystals containing 10 molecules of water (sal soda) are manufactured from soda ash in the following manner: The soda ash is dissolved in hot water to form a solution of about 1.3 specific gravity, a little sodium sulphate is added, and the solution is allowed to settle, the temperature being kept at about 34° C. The clear liquid is then run into crystallizing pans where the sodium carbonate is allowed to crystallize out. It has been found necessary that the finished crystals must contain about 1 per cent of sodium sulphate to give the desired crystalline form. After the crystallization is complete, the mother liquor is drained off, leaving the crystals to dry by draining or they are "whizzed"

to dryness in a centrifugal machine. The dry crystals are then packed in barrels, kegs, or bags for shipment.

Soda crystals containing one molecule of water (Na_2CO_3—H_2O) can be made by evaporating a solution of soda ash. These crystals are known as "monohydrated sodium carbonate" and contain over twice as much alkali as the sal soda crystals.

Crystals of sodium "sesquicarbonate" (Na_2CO_3—$NaHCO_3$—$2H_2O$) are made by crystallization from a hot solution containing 84 parts of sodium bicarbonate and 106 parts of sodium carbonate. This salt crystallizes in fine needles, does not effloresce or deliquesce, and is readily soluble in water.

History of the industry.—Sodium carbonate has been known from the earliest time. It is mentioned in the Old Testament by the name "neter," as a substance which served for cleansing and effervesced with vinegar. The word "natron" was first found in Europe in the fifteenth century to denote the natural alkaline carbonate or that made from plants. The Arabs sometimes called it "nitrum" but more frequently "kali" or "alkali." Even the expression "soda" is found in the early writings.

Soda ash was first made on a manufacturing scale from the ashes of marine plants, the plant ashes yielding from 2 to 40 per cent of their weight as sodium carbonate. Down to the last of the eighteenth century all the soda of commerce, except the natural mineral "trona," was made from the ashes of seashore plants. The Spanish soda was considered as being the best and its special name of "barilla" was conferred upon all soda made from plants.

In the latter part of the eighteenth century the French Government offered a prize for the development of a process for making soda that would be a substitute for the Spanish soda, which was cut off during the wars of Spain. This stimulation resulted in a process being patented by Nicolas Le Blanc in 1792 which was awarded the prize. The Le Blanc process was first established on a large scale at St. Dennis, France. This venture resulted in disaster, as the plant and patents of Le Blanc's were confiscated by the French revolutionary government and Le Blanc committed suicide. The process was later transferred to England, where it has had its greatest development and success. This process practically supplanted the manufacture of soda ash from sea plants, and up to the introduction of the "ammonia-soda" process produced nearly all of the soda of commerce.

The use of ammonia in the production of soda ash was first patented in about 1838, and since many patents have been filed with the idea of giving this method a commercial test. All commercial attempts, however, failed until Ernst Solvay, a Belgian, turned his attention to the problem. His first patents were taken out in 1861 and 1863. The first plant using Solvay's process was erected about 1866 at Couillet, Belgium. In 1872, Solvay received a visit from Mr. Ludwig Mond which led to the establishment of the plant of Brunner, Mond & Co., in England, which has become the largest alkali works in the world. The "ammonia-soda" process of Solvay's has been a serious competitor to the Le Blanc process. In 1902 over 90 per cent of the world's production of soda ash was produced by the "ammonia-soda" process. These figures show that the Le Blanc process has practically given away in favor of the "ammonia-soda" process.

The following table of the world's production of soda ash shows the relation between the production of soda ash by the Le Blanc and "ammonia-soda" processes up to the year 1902:

Years.	World's production.	Le Blanc.	Ammonia soda.
	Tons.	*Tons.*	*Tons.*
1850	150,000	150,000	.....
1863	300,000	300,000	.....
1864–1868	375,000	374,000	300
1869–1873	450,000	447,000	2,600
1874–1878	525,000	485,000	40,000
1879–1883	675,000	545,000	136,000
1884–1888	800,000	535,000	365,000
1889–1893	1,025,000	390,000	635,000
1894–1898	1,250,000	265,000	985,000
1902	1,760,000	156,000	1,616,000

Soda ash—Production of soda ash in United States.[1]

[From J. D. Pennock, Solvay Process Co., Syracuse, N. Y., with exceptions noted.]

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1900	362,806	.....	1914	980,224	.....
1904	600,008	.....	1915	1,175,962	.....
1909	740,455	.....	1916	1,194,183	$16,464,774
1910	770,978	.....	1917	1,390,625	38,028,000
1911	854,370	.....	1918	1,390,628	35,635,520
1912	935,612	.....	1919	981,054	29,895,343
1913	899,830	.....			

[1] Figures from 1900 to 1915, inclusive, supplied by Solvay Process Co., Syracuse, N. Y. Since then figures are those of United States Geological Survey.

Sal soda, including monohydrate crystals—Production in United States—Other sources.

[From United States Geological Survey.]

SAL SODA.

Years.	Short tons.	Value.
1917	77,939	$1,698,520
1918	82,465	2,020,271
1919	80,090	2,229,994

MONOHYDRATE AND SESQUICARBONATE OF SODA.

Years.	Short tons.	Value.
1918	22,678	$482,958
1919	30,796	710,748

Sodium carbonate or soda ash—Exports of the United Kingdom.

[From the official reports of the United Kingdom, calculated into United States units.]

Countries.	1910		1911		1912	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
United States	2,586	$30,207	1,735	$40,568	2,067	$44,334
Italy	8,086	151,992	8,128	153,819	9,414	154,695
China	19,045	379,271	21,514	430,553	22,886	420,977
Japan	18,420	340,041	24,025	445,677	32,144	539,347
Brazil	5,903	119,927	6,632	136,613	6,949	121,908
Argentine	9,909	206,600	8,838	180,125	8,855	170,237
Total foreign	83,857	1,636,099	88,784	1,732,359	110,101	1,927,160
British India	13,422	259,810	21,692	402,447	16,168	269,975
Australia	9,230	184,879	9,835	199,141	10,491	189,404
Canada	12,888	160,690	15,259	186,300	18,114	255,606
Total British Possessions	38,603	665,669	49,872	869,997	48,663	791,046
Grand total	121,460	2,291,755	138,656	2,602,356	158,854	2,718,206

Countries.	1913		1914		1915	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
United States	1,688	$35,371	1,285	$34,417	306	$8,915
Italy	9,373	132,078	23,866	353,028	42,994	730,245
China	26,434	437,288	30,304	517,314	29,309	485,028
Japan	35,346	520,083	37,864	564,213	26,574	400,214
Brazil	8,077	136,783	4,853	81,447	5,635	93,189
Argentine	11,881	212,571	5,876	107,130	8,571	151,576
British India	21,755	339,374	24,855	380,458	29,683	483,914
Australia	10,542	173,220	11,029	181,979	14,644	238,726
Canada	19,271	254,088	10,490	137,708	4,960	66,771
Total foreign	119,284	1,903,667	148,764	2,346,630	188,154	3,006,891
Total British	55,704	837,332	51,451	784,993	56,118	907,329
Grand total	174,989	2,740,998	200,215	3,131,023	244,273	3,914,220

Sodium carbonate or soda ash—Exports of the United Kingdom.

Countries.	1916		1917	
	Short tons.	Value.	Short tons.	Value.
United States	62	$2,569	22,922	$577,605
Italy	15,454	598,435	12,356	674,244
China	14,447	279,221	12,852	309,704
Japan	31,648	623,563	22,922	577,605
Brazil	4,436	92,785	4,025	138,432
Argentine	7,925	214,537	8,294	306,609
British India	25,461	530,730	42,946	993,545
Australia	12,613	223,291	17,907	389,086
Canada	11,589	197,603	12,331	223,757
Total foreign	118,378	3,009,324	98,205	2,872,491
Total British	57,359	1,115,453	81,209	1,859,139
Grand total	175,736	4,124,777	179,504	4,731,630

Soda crystals (sodium carbonate)—Exports of the United Kingdom.

Countries.	1910		1911		1912	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Netherlands	654	$8,817	699	$9,854	680	$9,693
Chile	1,542	20,427	2,215	31,196	1,362	19,483
Argentine	4,398	63,209	4,550	63,603	4,908	75,399
British India	913	14,856	1,118	17,644	1,005	17,985
Canada	2,494	25,936	2,709	28,578	2,138	23,921
Total foreign	8,431	125,480	8,958	131,255	8,735	138,919
Total British	5,484	73,180	6,121	81,690	5,260	75,131
Grand total	13,915	198,660	15,079	212,945	13,995	214,050

Countries.	1913		1914		1915	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Netherlands	565	$7,420	577	$7,839	380	$5,343
Chile	2,231	31,624	687	9,931	292	4,209
Argentine	4,917	72,615	3,902	55,531	5,200	74,635
British India	986	15,197	929	15,625	939	16,257
Canada	2,006	22,194	1,649	18,710	1,044	11,338
Total foreign	9,592	144,102	7,966	117,387	11,350	164,320
Total British	5,496	76,455	5,028	74,994	5,507	87,671
Grand total	15,088	220,557	12,994	192,381	16,857	251,991

Countries.	1916		1917	
	Short tons.	Value.	Short tons.	Value.
Netherlands	1,066	$34,028	570	$14,322
Chile	460	6,939	35	608
Argentine	3,171	55,365	767	17,398
British India	983	20,549	556	16,317
Canada	1,724	28,203	109	1,717
Total foreign	6,419	149,844	2,474	67,776
Total British	6,156	124,657	2,123	59,176
Grand total	12,575	274,501	4,597	126,952

Table is compiled from the official reports of the United Kingdom, the figures being converted into United States units.

Soda ash—Exports from Germany.

Countries.	1909		1910		1911	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Belgium	12,893	$250,614	11,644	$226,576	13,406	$272,034
Wales	8,094	157,318	8,961	174,216	7,927	167,076
Sweden	6,283	122,094	9,170	178,500	10,206	219,674
Switzerland	15,575	302,736	15,976	310,590	16,222	336,770
All others	17,223	334,390	17,202	333,438	18,639	391,034
Total	60,068	1,167,152	62,953	1,223,320	66,400	1,386,588

Soda ash—Exports from Germany—Continued.

Countries.	1912		1913	
	Short tons.	Value.	Short tons.	Value.
Belgium	20,517	$421,022	15,427	$302,736
Wales	8,078	168,504	9,303	192,066
Sweden	9,912	205,870	11,834	239,190
Switzerland	16,689	345,814	16,894	359,380
All others	18,394	381,752	23,696	473,620
Total	73,590	1,522,962	77,154	1,566,992

Soda ash—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	⅜ cent per pound	3,958,760	$41,607	$14,845	$0.011	35.68
1909	do	4,440,499	48,674	16,651	.011	34.21
1910	do	561,801	6,208	2,106	.011	33.94
1910	¼ cent per pound	4,428,226	49,054	11,070	.011	22.57
1911	do	3,878,172	43,365	9,695	.011	22.36
1912	do	2,905,587	33,459	7,264	.012	21.71
1913	do	3,100,790	35,461	7,752	.011	21.86
1914	do	280,598	2,949	701	.011	23.79
1914	Free	1,948,393	25,153		.013	
1915	do	2,127,542	29,022		.013	
1916	do	878,175	20,718		.023	
1917	do	1,047,295	29,239		.027	
1918	do	1,514,765	55,331		.036	

Sal soda—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	1/10 cent per pound	497,236	$3,419	$994	$0.006	29.01
1909	do	503,136	3,231	1,006	.006	31.14
1910	do	58,688	328	117	.006	35.79
1910	¼ cent per pound	357,907	2,480	596	.007	24.06
1911	do	214,419	1,512	357	.007	23.64
1912	do	253,634	2,020	422	.008	20.93
1913	do	128,027	1,010	213	.008	21.13
1914	do	28,495	351	47	.012	13.53
1914	⅛ cent per pound	135,131	923	168	.007	18.30
1915	do	104,800	606	131	.005	21.62
1916	do	67,210	334	84	.004	25.15
1917	do	50	4		.080	1.75
1918	do	75	3		.040	3.00
1919	do	44,800	1,156	56	.026	4.84

Soda ash—Domestic exports.

Exported to—	Fiscal year.		Calendar years.			
	1918		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Japan	74,146,230	$2,806,572	94,884,790	$3,417,074	18,941,838	$537,411
Canada	67,897,394	1,353,350	73,226,543	1,911,488	58,350,583	1,276,779
Cuba	10,614,426	192,832	10,428,222	178,487	2,896,391	48,293
Brazil	8,103,253	382,838	14,315,762	593,304	4,022,414	156,436
Argentina	7,114,067	206,718	3,639,771	133,203	515,865	15,564
Chile	5,809,223	183,060	5,706,625	179,455	222,981	7,319
Dutch East Indies	3,173,693	135,795	996,773	45,753	623,205	25,532
Philippines	2,506,768	85,206	1,086,819	38,946	155,080	8,100
Australia	3,928,847	166,646	11,335,610	476,287	2,901,274	141,601
Mexico	2,708,645	87,290	4,658,011	140,918	3,096,055	86,752
Sweden	2,024,398	70,522	2,613,835	81,863	3,175,174	134,658
Norway	1,071,066	33,621	7,287,082	280,265	266,175	9,558
Peru	1,050,745	45,295	746,802	32,004	368,440	13,563
Venezuela	1,288,990	45,411	1,603,763	56,958	75,827	2,038
China	1,563,073	76,185	1,409,182	69,316	1,477,619	60,136
All other	5,751,639	203,538	.....	.....	.....	.....
Total	198,752,457	6,074,879	238,434,992	7,805,550	100,961,927	2,656,608

NOTE.—Not listed separately until the fiscal year 1918. See Soda Salts General for total exports of soda salts prior to 1918.

Sal soda—Domestic exports.

Exported to—	Fiscal year.		Calendar years.			
	1918		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Canada	8,411,440	$110,208	9,237,685	$136,191	8,937,764	$133,569
Panama	350,925	7,433	328,605	7,381	276,485	6,516
Mexico	251,200	6,420	167,553	5,267	143,860	2,668
Jamaica	175,042	3,260	177,823	4,212	111,556	2,706
Cuba	1,470,950	26,950	1,358,567	27,028	809,974	13,085
Argentina	2,125,813	27,317	353,600	4,970	43,280	983
Brazil	200,442	4,783	44,150	592	86,733	1,540
Dutch East India	79,550	1,262	50,690	963	32,225	470
Japan	60,000	2,100	183,000	6,525	1,380	29
Philippines	1,866	52	4,800	108	53,577	1,395
All other	.....	.....	.....	.....	.....	.....
Total	11,076,264	205,489	12,716,453	213,865	11,126,370	178,285

NOTE.—Not listed separately prior to the year 1918, fiscal. See Soda Salts General for the total exports of Soda Salts.

Soda ash, light 58 per cent, prices (wholesale), per 100 pounds in bags, flat.

[From Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
1912	$0.72½–$0.82½	$0.67½–$0.75	$0.67½–$0.75	$0.60 –$0.70
1913	60 – 70	60 – 70	57½– 62½	57½– 62½
1914	57½– 62½	57½– 62½	57½– 62½	57½– 62½
1915	57½– 62½	57½– 62½	57½– 62½	57½– 62½
1916	1.75 – 2.00	3.50 – 3.75	2.75 – 3.00	3.25 – 3.50
1917	2.75 – 3.10	3.00 – 3.25	2.75 – 3.00	3.10 – 3.80
1918	2.85 – 3.02	2.80 – 2.85	2.00 – 2.05	2.50 – 2.60
1919	2.00 – 2.25	1.50 – 2.25	1.85 – 2.15	1.90 – 2.00
1920	2.20 – 2.30	3.50 – 3.60	3.50 – 3.75	2.65 – 2.85

Soda, sal, prices (wholesale) f. o. b. works (American) per 100 pounds.

[From Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
1912	$0.60–$0.80	$0.60–$0.80	$0.60–$0.80	$0.60–$0.80
1913	.60– .80	.60– .80	.60– .80	.60– .80
1914	.60– .80	.60– .80	.60– .80	.60– .80
1915	.60– .80	.60– .80	.60– .80	.60– .80
1916	.85– 1.00	1.10– 1.35	1.00– 1.15	1.00– 1.15
1917	1.10– 1.25	1.10– 1.25	1.10– 1.25	1.10– 1.25
1918	1.15– 1.35	1.35– 1.50	1.35– 1.50	1.40– 2.00
1919	1.60– 2.10	1.60	1.35	1.35
1920	1.35	1.60– 2.00	1.85– 2.00	2.00– 2.25

Soda ash and other carbonates of soda—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	A	Soda ash	¼ cent per pound.
		Soda, sal, or soda crystals	Do.
1890	83	Sal soda, or soda crystals, and soda ash	Do.
1894	67	Sal soda, or soda crystals	¼ cent per pound.
		Soda ash	¼ cent per pound.
1897	77	Sal soda, or soda crystals, not concentrated	0.2 cent per pound.
1897	78	Soda ash	¼ cent per pound.
1909	74	Sal soda, or soda crystals, not concentrated	¼ cent per pound.
1909	75	Soda ash	¼ cent per pound.
1913	67	Sal soda, and soda crystals	¼ cent per pound.
		Crystals, carbonate of, monhydrate, and sesquicarbonate of	Do.
1913	605	Soda ash	Free list.

Court and Treasury Decisions.

Caustic soda, classified by the collector as an unenumerated article under the act of 1857, was held dutiable as most resembling soda ash. (Gamble *v.* Mason, 9 Fed. Cas., 1140.)

Merchandise invoiced as "bleaching powder," found to consist of soap, carbonate of soda, and saponified resin, and to be applied to the same use as soda ash, was held dutiable under the act of 1890 as an unenumerated manufactured article. (G. A. 954, T. D. 13041.)

Washing soda was held dutiable under the act of 1890 as soda ash and nor as an unenumerated manufactured article. (G. A. 1214, T. D. 12530.)

Sodium carbonate, declared highly purified sal soda or soda crystals, was held dutiable accordingly under the act of 1890. (G. A. 1347, T. D. 12698; G. A. 1862, T. D. 13590; G. A. 1939, T. D. 13701.)

So-called crystal carbonate was held dutiable under the provision for products or preparations known as alkalies, and not as soda ash nor as sal soda. (G. A. 3030, T. D. 16006, affirmed by the Circuit Court for the Southern District of New York, T. D. 17602.)

Sodium carbonate containing sodium silicate, soap, and organic blue color was held dutiable as a chemical mixture under the act of 1909 and not as sal soda. (Abstract 34274, T. D. 34000.)

So-called ammonia-alkali was held dutiable under the act of 1890 as soda ash and not as a chemical compound or salt. (Appeal, T. D. 9326.)

A substance consisting of 31.57 per cent sodium perborate and 68.43 per cent sodium carbonate was held dutiable as a chemical compound under the act of 1909 and not as bleaching powder or chlorate of lime. (Abstract 35745, T. D. 34496.)

SODIUM CHLORATE.

[Par. 67, act of 1913. One-half cent per pound.]

Summary table.[1]

Year.	Imports for consumption (fiscal year).	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
	Pounds.			*Pound.*	*Per cent.*
1911	55	$2	$0.83	$0.036	41.50
1912	140	22	2.00	.157	9.55
1913	50	10	.75	.200	7.50
1914	469	[2] 43	[2] 1.00	[2] .181	[2] 2.77
1915	62	6	.31	.097	5.17
1916	22,176	3,105	110.00	.140	3.57
1917	33,600	1,080	168.00	.032	15.56
1918	44,800	8,064	224.00	.180	2.78
1919	10	2	.05	.200	2.50

[1] Domestic exports not separately shown in Commerce and Navigation.
[2] From Oct. 4, 1913, to June 30, 1914.

General Information.

DESCRIPTION AND USES.

PAR. 67. "Soda; * * *; chlorate of, * * *, ½ cent per pound; * * *."

Sodium chlorate is a colorless crystalline chemical compound composed of 21.6 per cent of sodium, 33.3 per cent of chlorine, and 45.1 per cent of oxygen. It has the chemical formula $NaClO_3$. It is very soluble in water and its solutions have a cooling saline taste.

Both sodium and potassium chlorates are excellent oxidizing agents. (See T. I. C. unit on potash for a description of potassium chlorate.) Sodium chlorate is used for oxidizing purposes in various technical processes, such as in the manufacture of coal-tar dyes, in the dyeing and printing of textiles; and larger quantities are used in the manufacture of matches and explosives. It was formerly believed that only potassium chlorate could be used in the manufacture of matches, since sodium chlorate was very hydroscopic. The scarcity and high price of potassium salts during the war lead to methods being perfected which permitted the use of sodium chlorate in the manufacture of matches instead of potassium chlorate. Sodium chlorate has generally replaced the more expensive potash salt wherever possible.

The chemical properties of sodium and potassium chlorates are very similar. There is considerable difference, however, in the solubility of the two salts. Potassium chlorate is only slightly soluble in cold water and very soluble in hot water. This fact makes it easy to manufacture this substance in a finely crystalline and pure condition. On the other hand, sodium chlorate is highly soluble in both cold and

hot water. This makes sodium chlorate more difficult to manufacture in a pure condition, but easier to use than potassium chlorate. The solubility of sodium chlorate in cold water gives it a preference over potassium chlorate in the manufacture of aniline black.

DOMESTIC PRODUCTION.

"The production of sodium chlorate in the United States in 1917 was large, but the total is withheld at the request of one of the three producers, whose product was largely exported and therefore does not represent domestic consumption."[1] The production of chlorates (both sodium and potassium chlorates) increased from 5,785 short tons, valued at $904,550 in 1909, to 8,304 short tons, valued at $1,131,316 in 1914. There were five producers in both 1909 and 1914.

Sodium chlorate is generally manufactured by electrolytic methods at the present time (1919). A saturated solution of sodium chloride (common salt) is subjected to the action of the electric current in a suitable apparatus known as an electrolytic cell. The current decomposes the salt into caustic soda and chlorine which are allowed to combine in the apparatus forming sodium chlorate and salt. When the concentration of sodium chlorate in the solution has reached a certain point the solution is removed from the apparatus. The solution is now evaporated and the salt precipitates out as it is the more insoluble. When the maximum concentration of sodium chlorate has been reached the solution is cooled; the sodium chlorate crystallizes from the solution. If a very pure product is required, the first batch of crystals are recrystallized from water. The mother liquor from the first crystallization is resaturated with salt and returned to the process. The salt which separates out during the evaporation is also returned to the apparatus for the production of more sodium chlorate.

The apparatus for the manufacture of sodium chlorate electrolytically is very expensive, as parts of the apparatus must be made from platinum, owing to the corrosive action of the intermediate products formed.

Sodium chlorate was formerly made by treating milk of lime with chlorine gas. Calcium chlorate was thus produced and was converted into sodium chlorate by treatment with sodium sulphate (salt cake). The sodium chlorate produced by this method was separated from the salt produced as described above.

Exports.—Exports of sodium chlorate are not separately shown in Commerce and Navigation, although it is known that there was export in 1917. (See above.)

Imports.—The imports of sodium chlorate are negligible even considering the large increase in imports since 1915. Confidential figures of production in 1917 show that the import in this year was a very small percentage of domestic production. The imports, which since 1915 have been between 22,000 and 45,000 pounds, may be regarded as negligible.

[1] Sodium Salts in 1917, Roger C. Wells, Mineral Resources of U. S. Department of the Interior.

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TARIFF HISTORY.

Sodium chlorate was specifically made free of duty by the acts of 1890 and 1894. The act of 1897 placed a duty of 2 cents per pound on chlorate of soda. This duty was reduced by the act of 1909 to 1½ cents per pound and by the act of 1913 to one-half cent per pound.

The import of sodium chlorate immediately following the act of 1913 did not increase. The import of sodium chlorate in 1916, 1917, and 1918 show considerable increase over the import in the preceding years, but this may be attributed directly to war conditions causing the substitution of sodium chlorate for the higher priced potassium chlorate.

Sodium chlorate—Production in United States.

[From Federal Census.]

Year.	Number of establishments.	Quantity.	Value.
		Short tons.	
1909	5	5,785	$904,550
1914	5	8,304	1,131,316

Soda, chlorate of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Acutal and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	2 cents per pound					
1909	do	150	$12	$3	$0.080	25.00
1910	1½ cents per pound.					
1911	do	55	2		.036	41.50
1912	do	140	22	2	.157	9.55
1913	do	50	10		.200	7.50
1914	do	231	41	3	.177	8.46
1914	½ cent per pound	238	43	1	.181	2.77
1915	do	62	6		.096	5.17
1916	do	22,176	3,105	110	.140	3.57
1917	do	33,600	1,080	168	.032	15.56
1918	do	44,800	8,064	224	.180	2.78
1919	do	10	2		.200	2.50

Sodium chlorate, prices (wholesale), spot, New York, cents per pound.

[From Oil, Paint and Drug Reporter.]

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	8½–9½	8½–9½	7½–8	.14	25	25–35	18–25	18–20	10–12
April	8½–9½	8½–9½	7½–8	14–16	35	24–30	24–26	15–18	10–12
July	8½–9½	8½–9½	7½–8	14–16	35	23–26	18–25	15–16	10–11
October	8½–9½	8½–9½	12	14–16	28–35	23–25	18–24	15–16	10–11

Chlorate of soda—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1890	709	Soda, chlorate of	Free.
1894	621	do	Free.
1897	75	do	2 cents per pound
1909	72	do	1½ cents per pound.
1913	67	do	½ cent per pound.

SODIUM CHROMATE AND OTHER CHROMIUM COMPOUNDS.

SUMMARY.

Description.—The most important chromium salts are the chromates and bichromates of soda and potash. The bichromates or acid chromates are usually preferred as they are richer in chromic acid (CrO_3). For general commercial uses the soda salts have largely replaced the potash salts, owing to the high cost of potash. For purposes where purity is essential, as in analytical laboratory work, the potash salts are preferred because they are more easily recrystallized and purified.

The other chromium salts which are commercial articles are chromic acid, chromium hydroxide, and chrome alum.

The chromium salts are used chiefly for the chrome tanning of leather, textile dyeing and printing, manufacture of chrome colors and pigments, pickling of brass, and the electroengraving of copper plates. They are also used for other chemical purposes.

Domestic production.—The production of bichromate of soda has increased from 11,824 short tons in 1914 to 19,646 short tons in 1917. The production of other chromium salts is not available.

The domestic production has supplied practically all of our consumption, especially since 1910, as the imports have been insignificant in quantity.

All chromium salts are made from the mineral chromite or chrome iron ore, the larger part of which is imported. This ore is fused with lime and soda ash. Sulphuric acid is necessary to convert chromates into dichromates.

The manufacture of chromium salts is located largely along the Atlantic coast. There are two factories at Jersey City, N. J.; two at Newark, N. J.; one each at Baltimore, Md.; Niagara Falls, N. Y.; Cleveland, Ohio; Kensington, Ill.; and Napa, Calif.

Foreign production.—There is no information available on foreign production.

Imports.—During the years 1909 and 1910 about 3,000,000 pounds of chromates and bichromates were imported each year. One of the leading manufacturers in this country said that these large imports during 1909 and 1910 were evidently due to an overproduction in Europe. The manufacturers in this country began exporting to Europe with the result that imports practically ceased. Since 1910 the imports have been insignificant in quantity.

Prices.—Bichromates of potash and soda show perhaps a greater variation in price than almost any other chemicals. Bichromate of potash varied from a prewar price of 7 cents per pound to a maximum price of 75 cents in April, 1916, while bichromate of soda rose from about 6 cents per pound in 1912 to 60 cents in 1916.

Bichromate of soda is about ten times as soluble in water as bichromate of potash and is frequently preferred to the potash salt. The

soda salt is very much cheaper and for this reason has, to a large extent, replaced the potash salt.

The present prices, October, 1920, are 32 cents for the former and 17½ cents for the latter. During the war the imports of chrome ore were cut off and the price of chromates rose. Although the production of bichromate of soda in the country has been doubled from 1914 to 1917, the active demand for the commodity commanded a high price in 1916. A break was caused, with a drop in price at this time, by the offering on the market of goods sold for export but for which no cargo room could be obtained.[1] For a time the spot price was lower than the contract prices. These chromates show the greatest advance in prices of any of those used mainly for tanning, but their other uses affect their price, such as textile dyeing and printing, manufacture of chrome colors and pigments, bleaching oils and fats, as well as numerous other uses.

High prices for chrome ore and soda ash, abnormal demand for both home and export consumption, and speculative buying were the main reasons for such spectacular advances, which caused bichromate of soda to sell at the highest price in the history of the trade.

Tariff history.—Chromate of soda was dutiable under the act of 1890 at 3 cents per pound. The act of 1894 changed the duty to 25 per cent ad valorem. The act of 1897 levied a duty of 2 cents a pound, which was reduced to 1¾ cents by the act of 1909 and to ¾ cent by the act of 1913.

Chromate and bichromate of potash were dutiable at the same rate as the soda salts under the acts of 1890 and 1894. The act of 1897 levied a duty of 3 cents per pound on chromate and bichromate of potash. This duty was reduced by the act of 1909 to 2¼ cents per pound and by the act of 1913 a further reduction to 1 cent took place.

Chromic acid was dutiable under the act of 1883 at 15 per cent ad valorem. The act of 1890 levied a specific duty of 6 cents per pound, which was reduced by the act of 1894 to 4 cents, by the act of 1897 to 3 cents, by the act of 1909 to 2 cents, and the act of 1913 placed chromic acid on the free list.

Chromium hydroxide, crude, was first mentioned in the act of 1913 on the free list.

General Information.

CHROMATE OF POTASH AND SODA.

Description.—Chromate of potash is the potash salt of chromic acid or chromic anhydride. It contains about 51.5 per cent of chromic acid. It is not prepared, however, from chromic acid but always from the mineral chromite. The potash salt crystallizes from a water solution in yellow rhombic prisms containing no water of crystallization. The crystals are readily soluble in water, but to a less degree than the corresponding soda salt. The solution of chromates has a fine yellow color of great tinctorial power.

The soda salt of chromic acid or sodium chromate forms large yellow crystals containing 10 molecules of water of crystallization.

[1] Oil, Paint, and Drug Reporter, vol. 91, No. 1, p. 149, 1917.

The crystals on exposure to the air gradually lose their water of crystallization. Sodium chromate is very similar, chemically, to the potassium salt and the two can be used interchangeably for most purposes. The soda crystals contain only 29.2 per cent of chromic acid, an amount which is considerably less than the potash crystals. This is due to the large percentage of water which the soda crystals contain.

Both of the chromates when treated with an acid, even carbonic acid, are converted into the dichromate or acid chromate, which is described later.

Uses.—The chromates of soda and potash are not used to such an extent as the dichromates. The dichromates are preferred on account of their greater richness in chromic acid and the fact that they are more easily recrystallized and purified. The chromates, however, have important analytical and laboratory uses.

Preparation.—All of the chromium salts are prepared from chrome iron ore [1] or chromite. This ore is finely pulverized and mixed with lime and sodium carbonate (soda ash). A small quantity of calcium carbonate (limestone) is usually added, as the carbon dioxide evolved from it renders the mass porous. This mixture is heated in a reverbatory furnace in the presence of a strong current of air. At the end of the reaction the mass consists of a mixture of calcium and sodium chromate, sodium carbonate, and ferric oxide. This mass is then lixiviated with water; the calcium chromate and excess sodium carbonate combine to form sodium chromate and calcium carbonate, which is insoluble and precipitates, leaving a solution of sodium chromate. This solution is just made acid with sulphuric acid, which removes any alumina and silica. The clear solution of sodium chromate is now evaporated and as the dichromate is usually preferred, the solution, on reaching a specific gravity of about 56° Baumé, is treated with the required quantity of sulphuric acid to convert the chromate into the dichromate. The dichromate is then crystallized out of the solution. During the manufacture of chromates and dichromates the workmen must avoid breathing the dust containing chromates as they attack the cartilages of the nose and throat.

The chromate salts resulting from the reduction of dichromate in oxidation processes may be recovered by oxidizing to dichromate by different methods. Thus the dichromate may be recovered and used again.

BICHROMATE OF POTASH AND SODA.

Description.—Bichromate of potash, potassium dichromate or "bichrome," is the acid chromate of potash. Chemically it has the formula $K_2Cr_2O_7$, and contains two molecules of chromic acid (CrO_3), or about 68 per cent by weight. It is about 16.5 per cent richer in chromic acid than potassium chromate. It crystallizes in anhydrous fine red square plates. When heated to bright redness the crystals decompose into chromate of potash and chromic sesquioxide.

Bichromate of soda in chemical composition is similar to bichromate of potash with the exception that the potassium is replaced by sodium. It crystallizes in thin red prisms containing two molecules

[1] The larger part of the chrome iron ore is imported into this country. See survey on chromite of chrome iron ore.

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of water ($Na_2Cr_2O_7$-$2H_2O$). The crystals contain about 66.7 per cent of chromic acid. They are very deliquescent, but if dried at 200° C. they lose their water of crystallization and become anhydrous, in which condition they are no longer deliquescent. Bichromate of soda is about ten times as soluble in water as the bichromate of potash, and for this reason it is frequently preferred to the potash salt. The soda salt is also very much cheaper and to a large extent for this reason has replaced the potash salt.

Uses.—The uses of chromates and bichromates in the order of their importance are listed below:

1. Chrome tanning of leather.
2. Textile dyeing and printing.
3. Manufacture of chrome colors and pigments, especially lead and barium chromates (chrome or lemon yellows).
4. Pickling of brass.
5. Electro-engraving of copper plates.

It is also used as a laboratory reagent, in bleaching oils and fats, and for other oxidation purposes.

The preparation of dichromates has been discussed under chromates above.

CHROMIC ACID.

Chromic acid or chromic anhydride is an oxide of chromium having the chemical formula CrO_3. It is a strong acid substance crystallizing in scarlet needles, which melt at 193° C. and on further heating to 250 degrees decompose with the liberation of oxygen. Chromic acid is very soluble in water and dissolves in acetic acid and in certain strengths of sulphuric acid.

It is a powerful oxidizing agent and the addition of oxalic acid is said to increase this property. Solutions of chromic acid in water and acetic or sulphuric acid are largely used as an oxidizing agent in organic chemical work. Chromic acid is liable to contain impurities, such as sulphuric acid, sulphates, and nitrates.

Chromic acid is usually prepared by treating a chromate with sulphuric acid. Concentrated sulphuric acid is slowly added to a saturated solution of a chromate with constant stirring. On cooling scarlet crystals of chromic acid separate; if necessary, the solution is evaporated until the crystals separate on cooling. The liquid is poured off and the crystals dried on a porous plate. The crystals may be purified by recrystallization from water.

CHROMIUM HYDROXIDE.

Chromium hydroxide is a chemical compound having the formula $Cr(OH)_3$. It is a grayish-green gelatinous substance. It is converted by calcining into chromium oxide, which is insoluble in water and only slightly soluble in acids and alkalis and is used as a paint pigment.

OTHER COMPOUNDS.

Other compounds of chromium which are not mentioned in the act of 1913 but which are articles of commerce are chrome acetate and chrome alum.

Chrome acetate is used in commerce to designate normal chromic acetate, which has the chemical formula $Cr(C_2H_3O_2)$—H_2O. It is sold

in the form of a grayish-green powder and is used as a mordant in textile dyeing.

Chrome alum is a double salt of potassium sulphate and chromium sulphate. It has the chemical formula $K_2SO_4—Cr_2SO_4—24H_2O$. The compound does not contain aluminium as the name might indicate. It is very similar to all alums in that it is a double sulphate and crystallizes with 24 molecules of water. The crystals are dark violet red in color.

It is obtained as a by-product from the oxidation of organic substance by a mixture of potassium dichromate and sulphuric acid, as in the manufacture of alizarin and anilin violet. It is used as a mordant in dyeing, in calico printing, in leather tanning, in rendering glue and gums insoluble, in the manufacture of other chromium salts, and in waterproofing fabrics.

Sodium or ammonium may replace the potassium in chrome alum, the sodium compound being more soluble in water than the potassium salt.

IMPORTS OF CHROMATE AND BICHROMATES.

During the seventies and eighties large quantities of chromates and bichromates were imported into the United States. From this period until 1909 there were no imports of consequence, the domestic production supplying our demand. In the years 1909 and 1910 there was imported each year about 3,000,000 pounds of chromates and bichromates. One of the leading manufacturers in this country said that these large imports during 1909 and 1910 were evidently due to an overproduction in Europe. The manufacturers in the United States started exporting to the European countries which were the origin of the imports into this country. This procedure resulted in a cessation of imports, and since 1910 the imports of chromates and bichromates have been insignificant in quantity.

Bichromate of soda—Production in United States.

[From Federal Census.]

OFFICIAL SOURCE.

In 1914, 11,824 short tons, valued at $1,125,398. (Not shown prior to 1914.)

OTHER SOURCES.

In 1917 the Geological Survey reports 22,446 short tons, valued at $9,045,133, for chromate and bichromate of soda.

Iron, chromate of—Imports by countries (fiscal years).

Imported from—	1909		1910		1911	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Europe:	*Tons.*		*Tons.*		*Tons.*	
Belgium	2,018	$28,649	3,558	$49,720	.....	.....
Greece	3,500	33,214	7,740	68,126	4,500	$48,188
North America: Canada	3,978	50,042	241	2,892	15	150
Asia:						
Japan	2,781	20,529	2,290	16,959	449	3,680
Turkey	.....	.....	1,100	7,000	4,500	31,121
Africa: Portuguese	4,042	63,926	19,455	236,691	16,318	198,538
Oceania: French	11,878	125,728	9,466	89,521	8,957	114,239
All other	1,595	18,496	1,103	11,614	3,400	41,365
Total	29,792	340,584	44,953	482,523	38,139	437,281

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Iron, chromate of—Imports by countries fiscal years—Continued.

Imported from—	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Europe:	*Tons.*		*Tons.*		*Tons.*	
Greece	7,540	$70,595	.....	.....	8,450	$87,931
Portugal	15,455	188,577	5,000	$60,831	.....	.....
North America: Canada	13	258	.....	.....	533	9,283
Asia:						
Japan	190	1,381	322	2,712	.....	.....
Turkey	11,030	71,214	13,830	100,227	14,530	107,292
Oceania: French	6,600	41,399	6,620	47,913	25,970	166,915
Africa: Portuguese	5,100	62,048	24,000	291,981	30,001	364,989
All other	1,079	7,663	.....	.....	58	717
Total	47,007	443,135	49,772	503,664	79,842	737,127

Imported from—	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Europe:	*Tons.*		*Tons.*		*Tons.*	
Greece	4,305	$37,694	8,805	$117,254	3,400	$40,80
Portugal	.....	.....	.....	.....	.....	.....
North America: Canada	356	4,202	15,783	194,591	14,749	271,052
Asia: Turkey	5,700	42,636	.....	.....	.....	.....
Oceania: French	18,410	118,231	37,474	252,221	34,807	326,781
Africa:						
Portuguese	15,430	206,718	7,850	122,149	42,800	918,908
British, South	2,850	34,673	35,650	491,027	16,050	76,210
All other	.....	.....	1,507	19,008	1,520	14,977
Total	47,051	444,154	107,069	1,196,250	113,326	1,648,728

Chromate of iron or chromic ore—Imports by countries (fiscal years).

Imported from—	1918		1919	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Greece	.....	.....	.....	.....
Portugal	.....	.....	.....	.....
Canada	17,935	$394,258	.....	.....
Brazil	12,820	511,055	.....	.....
Australia	4,112	189,233	.....	.....
French Oceania	20,400	227,835	.....	.....
Africa:				
Portuguese	21,000	184,001	.....	.....
British South Africa	1,000	4,867	.....	.....
All other	514	31,512	.....	.....
Total	77,781	1,542,761	71,592	$2,439,830

Soda: Chromate and bichromate of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	2 cents per pound.	6,969	$425	$139	$0.061	32.80
1908	do.	108,089	4,304	2,162	.040	50.23
1909	do.	2,412,032	97,661	48,240	.040	49.40
1910	do.	245,575	9,621	4,911	.039	51.05
1910	1½ cents per pound.	2,418,742	92,066	42,328	.038	45.98
1911	do.	11	1		.091	19.00
1912	do.					
1913	do.	9	3		.333	5.33
1914	do.					
1914	¼ cent per pound.	11,056	542	82	.049	15.30
1915	do.					
1916	do.	6,154	3,630	46	.589	1.27
1917	do.					
1918	do.	27,127	5,259	203	.193	3.87
1919						

Potash, chromate and bichromate of—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	3 cents per pound.	9,428	$685	$283	$0.073	41.14
1908	do.	118,325	8,447	3,549	.071	42.02
1909	do.	171,541	12,330	5,146	.072	41.74
1910	2½ cents per pound.	877,151	43,037	19,735	.049	45.86
1911	do.	22,880	1,699	514	.074	30.30
1912	do.	24,094	2,273	542	.094	23.85
1913	do.	27,671	2,601	622	.094	23.94
1914	1 cent per pound.	34,860	2,822	348	.081	12.35
1915	do.	40,227	3,317	402	.082	12.12
1916	do.	2,291	391	22	.170	5.86
1917	do.	2,404	962	24	.400	2.50
1918	do.	20	8		.400	2.50
1919	do.					

Acid, chromic—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	3 cents per pound.	1,458	$303	$44	$0.208	14.43
1908	do.	1,735	433	52	.249	12.02
1909	do.	5,240	964	157	.184	16.31
1910	do.	506	77	15	.152	19.71
1910	2 cents per pound.	8,869	1,463	177	.165	12.12
1911	do.	8,643	1,456	172	.168	11.87
1912	do.	7,867	1,407	157	.179	11.18
1913	do.	8,522	1,682	170	.197	10.13
1914	do.	618	156	12	.253	7.92
1914	Free.	7,160	1,064		.149	
1915	do.	6,505	1,394		.214	
1916	do.					
1917	do.					
1918	do.	9,512	1,857		.195	
1919	do.					

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Bichromate of soda, prices (wholesale), spot, New York, per pound.

[From Oil, Paint, and Drug Reporter.]

Kinds or grades.	January.	April.	July.	October.	Low.	High.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1912	5.6–6.0	5.6–6.0	5.6 –6.0	5– 5½	5.0	6.0
1913	5– 5½	4.5–4.8	4.5 –4.8	4.6–4.8	4.5	5.5
1914	4.6–4.8	4.6–4.8	4.75–4.8	4.75–5.5	4.6	5.5
1915	4½– 5½	4½– 5½	10– 11	16	4½	.....
1916	25	60– 70	30– 41	26– 29	25	70
1917	19– 20	16½– 20	15½– 16	26–26½	15½	26½
1918	17– 18	23– 25	27½–29½	22½– 24	17	29½
1919	16½– 18	10– 12	7½– 8	13½– 14	7½	18
1920	17½– 20	34– 36	25½–26½	17½– 19	17½	36

Bichromate of potash, prices (wholesale), spot, New York, per pound.

[From Oil, Paint, and Drug Reporter.]

Kinds or grades.	January.	April.	July.	October.	Low.	High.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1912	7.4–7½	7.4–7½	7.4–7½	6½– 7	6½	7½
1913	6.8– 7	6.8– 7	6.8– 7	6½– 7	6½	7
1914	6½– 7	6½– 7	6½– 7	13–15	6½	.....
1915	12–13	16–17	21	20–21	12	.....
1916	45	75	43–45	38–50	38	.....
1917	42–43	35½–38	36–37	45–46	35½	46
1918	42–44	43½–45	45–47	42–44	42	47
1919	38–41	35–38	25–33	26–28	25	41
1920	30–32	38–40	45–47	32–33	30	47

Rates of duty.

SODIUM CHROMATE AND BICHROMATE.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1890	82	Soda: Bichromate and chromate of	3 cents per pound.
1894	66	.....do	25 per cent ad valorem.
1897	74	.....do	2 cents per pound.
1909	71	.....do	1½ cents per pound.
1913	67	.....do	¼ cent per pound.

CHROMATE AND BICHROMATE OF POTASH.

1883	48	Chromate of potash	3 cents per pound.
1890	69	Potash, bichromate and chromate of	Do.
1894	54	Potash, bichromate and chromate	25 per cent ad valorem.
1897	62	.....do	3 cents per pound.
1909	60	Bichromate and chromate of potash	2½ cents per pound.
1913	64	Potash, chromate and bichromate of	1 cent per pound.

CHROMIC ACID.

1883	47	Chromic acid	15 per cent ad valorem.
1890	3	.....do	6 cents per pound.
1894	3	.....do	4 cents per pound.
1897	1	.....do	3 cents per pound.
1909	1	.....do	2 cents per pound.
1913	387	Acids, chromic	Free list.

CHROMIUM, HYDROXIDE OF, CRUDE.

1913	449	Chromium, hydroxide of, crude	Free list.

Court and Treasury Decisions.

Bichromate of soda was held dutiable as a chemical compound and not by similitude as bichromate of potash under the act of 1883.—Mason *v.* Robertson, 139 U. S., 624, reversing 29 Fed., 684, and overruling Biddle *v.* Hartranft, 29 Fed., 90.

Hydroxide of chromium in the state of its first production, unrefined and unfit for use for dyeing or tanning, without being subjected to refining processes, was held free of duty as an article in a crude state used in dyeing or tanning n. s. p. f., and not dutiable as a chemical compound under the acts of 1897 and 1909.—United States *v.* Continental Color & Chemical Co., 2 Ct. Cust. Appls., 165 (T. D. 31679), affirming G. A. 7132 (T. D. 31102).

Chromium fluorine was held dutiable as a chemical salt and not as a coal-tar color or dye under the act of 1890.—G. A. 1874 (T. D. 13602).

PRUSSIATES AND CYANIDES OF POTASH AND SODA.

SUMMARY.

Description.—The prussiates of potash and soda are double salts of prussic acid, the other base material being iron. The ferrous iron salts (ferrocyanides) are the yellow prussiates, while the ferric iron salts (ferricyanides) are the red prussiates.

The prussiates are used for making Prussian blue and other blue colors; for calico printing and dyeing; ferricyanide is used as a part of the sensitive coating for "blue-print papers." Owing to the shutting off of potash salts from Germany, the sodium salts have almost entirely replaced the potash salts.

Potassium and sodium cyanide are both white salts of prussic acid and their properties are very similar. The cyanides are used for extracting precious metals from their ores by the "cyanide process"; for fumigating citrus fruits, raw imported cotton, grain elevators; for the bath in electroplating; and for the casehardening of iron.

Domestic production.—The production of prussiates and cyanides of all kinds during 1914, as shown by the census of manufactures amounted to about 8,000 short tons. Confidential figures for 1917 on the soda salts alone show a considerable increase over the 1914 production. This increase has been due probably to the reduction of imports caused by the war.

Prior to the war our production did not supply our total consumption, as considerable quantities were imported.

Until recently the cyanides were made in this country chiefly from metallic sodium, ammonia, and coke by the Castner process, a single firm controlling practically the entire production. During 1917 and 1918 there have been new processes developed (cyanamid and Bucher process) which will offer strong competition to the Castner process. The prussiates are then made from the cyanide.

Cyanides are produced chiefly at Perth Amboy, N. J. Manufacture of these products by the Bucher process had been started at Saltville, Va., but the plant has been taken over by the Government for nitrogen fixation. Potassium prussiates are also made at Niagara Falls, N. Y.

Foreign production.—Figures on foreign production are not available. Manufacturers in this country report that their competition has been chiefly from Germany and England. Germany is undoubtedly the largest producer.

Imports.—The imports of cyanides have been chiefly from Germany and England, with Germany furnishing a larger quantity. In 1915 the imports of potassium cyanide were chiefly from Austria-Hungary and Canada and were probably reexported especially from Canada.

The imports are competitive with the domestic production.

Prices.—The prices of prussiates and cyanide of potash have increased to 10 times the price prevailing prior to the war. Prussiate of soda prices increased to a maximum in 1916 of 15 times the prewar price and in 1917 the price was about 4 times the prewar prices. All these advances in prices are due to the shutting off of potash salts from Germany. Cyanide of soda was not listed prior to the war, but since potash salts could not be obtained from Germany, sodium salts have replaced them, so the price of cyanide of soda has increased 800 per cent from 1916 to 1918. The price of cyanide of soda dropped to 26 cents in July, 1919, and remained around that to the present time, due to small demand for the product and the competition of imports.

Tariff history.—Prussiates of potash were dutiable under the acts of 1883 and 1890 at 10 cents per pound for the red, and 5 cents per pound for the yellow. The act of 1894 made both the red and yellow dutiable at 25 per cent ad valorem. Under the acts of 1897 and 1909 the red was dutiable at 8 cents per pound and the yellow at 4 cents. The act of 1913 reduced the duty to 2 and 1¼ cents per pound, respectively.

Prussiate of soda, yellow, was not mentioned specially until the act of 1909, which imposed a duty of 2 cents per pound. The act of 1913 reduced this duty to ¾-cent per pound.

Cyanide of potash was first mentioned specifically in the act of 1897. This act and the act of 1909 imposed a duty of 12½ per cent ad valorem. The act of 1913 placed cyanide of potash on the free list.

Cyanide of soda was first mentioned specifically in the act of 1913 on the free list. Prior to the act of 1913 it was dutiable as cyanide of potash. (T. D. 22521).

General Information.

PRUSSIATES OF POTASH AND SODA.

Description and uses.—The prussiates of potash and soda are double salts of prussic acid. The other base material besides potash or soda is either ferrous or ferric iron. The ferrous salts are yellow, while the ferric salts are a deep red color.

Yellow prussiate of potash is potassium ferrocyanide, $K_4Fe(CN)_6.3H_2O$.

Red prussiate of potash is potassium ferricyanide, $K_3Fe(CN)_6$.

Yellow prussiate of soda is sodium ferrocyanide, $Na_4Fe(CN)_6.10H_2O$.

Red prussiate of soda is sodium ferricyanide, $Na_3Fe(CN)_6.H_2O$.

Potassium ferrocyanide, or yellow prussiate of potash, forms large orange-yellow crystals which do not change on exposure to the air, but they lose all of their water of crystallization on being heated to 100° C., at the same time they lose their color, being converted into a white powder. This chemical compound is largely used for making Prussian blue; in calico printing and dyeing; for the casehardening of iron; for making potassium cyanide and ferricyanide; and to a certain extent as a chemical reagent.

Potassium ferricyanide, or red prussiate of potash, crystallizes in deep red prism like crystals without water of crystallization. A

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solution of the salt is intense yellow in color. When treated with ferrous iron salts it gives a blue pigment known as "Turnbull's Blue." An alkaline solution of potassium ferricyanide is a powerful oxidizing agent, and is used as such in calico printing for a "discharge" on indigo and other dyes. Potassium ferricyanide is also used as part of the sensitive coating for "blue-print papers."

Sodium ferrocyanide, or yellow prussiate of soda, crystallizes in large lemon-yellow crystals containing 10 molecules of water of crystallization. These crystals like yellow prussiate of potash lose all of their water of crystallization on heating to 100° C. In fact, sodium and potassium ferrocyanide are very similar in their properties, one salt can be substituted for the other in most cases. Owing to the shutting off of potash salts by the war the sodium salt has replaced the potassium ferrocyanide entirely. It is not likely potassium ferrocyanide or ferricyanide will again be used to the same extent as it was in the past.

Sodium ferricyanide, or red prussiate of soda, is known and crystallizes with one molecule of water. This salt, however, is not as common an article of commerce as are the other prussiates.

Preparation.—The ferrocyanides or yellow prussiates were formerly made by fusing iron filings and nitrogenous animal materials of any kind (horn, blood, hair, wool waste, and leather scrap) with potassium or sodium carbonate depending on the salt which was desired. This method has been replaced by more modern and economical processes. It is known, however, that one firm in this country is using this old method to produce potassium ferrocyanide from scrap leather.

Ferrocyanides are now prepared from cyanogen gas (C_2N_2) and hydrocyanic gas (HCN) present in coal gas. These two gases are converted into ferrocyanides by two different methods. (1) The cyanogen and hydrocyanic acid are removed from the coal gas after the tar has been removed by "scrubbing" with a dilute solution of ferrous sulphate. These two products, along with some ammonia present in the gas, combine with ferrous sulphate, forming an insoluble salt of iron-ammonium-cyanide. This salt is then converted into calcium ferrocyanide by treating with lime. The calcium salt is then converted into a double ferrocyanide of potassium and calcium by means of potassium chloride. This salt is changed into potassium ferrocyanide by further treatment with potassium carbonate. The solution is filtered and the ferrocyanide of potash crystallized from the filtrate. (2) Ferrocyanide is also produced from coal gas during the process of purifying the gas from hydrogen sulphide. Iron oxide is used to remove the hydrogen sulphide from the gas, and at the same time the cyanogen and hydrocyanic acid combine with the iron oxide, and on exposure to the air oxidation to ferrocyanides takes place. The spent iron oxide from this process contains considerable ferrocyanide and is either recovered by the gas company or the spent oxide is sold to a chemical company who does the recovery.

Sodium ferrocyanide can be produced from the crude sodium cyanide produced by the Bucher process of nitrogen fixation. This process is at present (1918) being developed, and it has a very promising future. The crude cyanized briquettes produced in the process are treated with sufficient water to form a stiff paste. This paste is then steamed in an agitated vessel. The sodium cyanide and iron

in the briquettes react with the water to form sodium ferrocyanide, caustic soda, and hydrogen. The solution is filtered, and on cooling a fine quality of sodium ferrocyanide crystallizes out of the filtrate. With this process developed to a commercial scale, it will offer serious competition to the other methods of producing ferrocyanides.

The ferricyanides or red prussiates are prepared from the ferrocyanides by oxidation with chlorine gas. The ferrocyanides are usually treated with chlorine while dissolved in water. An excess of chlorine must be avoided. Other methods of preparation are mentioned, but this is the one usually employed. The ferricyanides are then crystallized from the solution in the same manner as the ferrocyanides.

Sodium ferrocyanide is also prepared by lixiviating sodium cyanide with hot water in the presence of iron, the sodium cyanide and iron combining chemically to form sodium ferrocyanide. This process is used to convert sodium cyanide prepared from cyanamid and by the Castner process into ferrocyanide.

CYANIDES OF POTASH AND SODA.

Description and uses.—The cyanides of potash and soda are described in the act of 1913 by the following language:

Paragraph 580. Potash, cyanide of. (Free list.)

Paragraph 605. Soda, cyanide of. (Free list.)

Potassium and sodium cyanide are both white salts of prussic acid, and their preparation and properties are very much alike; so they can be discussed together.

The cyanides are exceedingly poisonous when taken internally. When treated with an acid, they liberate prussic acid, or hydrocyanic acid, which is a very poisonous gas. The cyanides come into commerce as white lumps or powder and are very soluble in water. The salts smell like bitter-almond oil or crushed peach kernels, owing to the evolution of traces of prussic acid by the action of the carbon dioxide and moisture of the atmosphere.

Potassium cyanide contains, theoretically, 40 per cent of cyanogen (CN), which is the active constituent. The commercial product contains about 38 per cent of cyanogen. Sodium cyanide, owing to the lower molecular weight of sodium, contains 53 per cent of cyanogen, and consequently has a reactive value of 1.3 times that of cyanide of potash. Commercial grades of these two salts and mixtures of them are usually assayed as potassium cyanide. Therefore, mixtures containing considerable cyanide of soda will show on analysis over 100 per cent cyanide of potash. The commercial grades may assay as low as 65 per cent cyanide of potash, but 95 to 98 per cent is customary, and those products containing much sodium cyanide will, as pointed out, run over 100 per cent potassium cyanide.

The two biggest uses for sodium cyanide are the "cyanide process" of extracting precious metals from their ores, and fumigation. Sodium cyanide or hydrocyanic acid generated from the same is used for fumigating citrus fruits, raw cotton imported into the United States, railroad cars coming into this country from Mexico, grain elevators, and rooms. The property of a solution of cyanide to dissolve precious metals (gold and silver) gives sodium cyanide its large use in the mining industry. This same property gives cyanides their

third largest use in electroplating, where the bath is a cyanide solution of the metal, gold or silver. Cyanides are also used in the case-hardening of iron, and for this purpose a mixture of cyanide and chloride (salt) is usually employed.

For fumigation purposes one of the large manufacturers places sodium cyanide on the market in the shape of an egg, under the trade name "Cyanegg." Each egg of sodium cyanide weighs 1 ounce.

Preparation.—Potassium or sodium cyanide was formerly produced from the corresponding ferrocyanide by fusion with potassium or sodium carbonate and carbon. This method has, however, been replaced by the process of Castner, which is in general use at the present time (1918).

Castner process.—In this process sodium and ammonia are combined at between 300° and 400° C. to form sodium amide ($NaNH_2$), which is then run onto an excess of red hot charcoal (carbon), producing first sodium cyanamide which combines with more carbon to form sodium cyanide. This process produces a crude fused mass containing very small quantities of solid impurities. These impurities are easily removed by filtration and the molten cyanide is cast in iron molds. The pure white molded product contains 97 to 98 per cent of sodium cyanide, which is equivalent to 129 to 130 per cent of potassium cyanide.

Cyanamid process.—Cyanides are easily made from cyanamid or lime nitrogen. (See catalog on calcium cyanamid.) When crude cyanamid is fused with ordinary salt (sodium chloride) the carbon in the crude cyanamid and the salt combine with the calcium cyanamid to form sodium cyanide. The product resulting from this fusion is sufficiently pure for use in the "cyanide process" of gold extraction and is equally as efficient as pure cyanide of potash or soda for this purpose. Cyanides are manufactured by this process by the American Cyanamid Co., Niagara Falls, Canada. Potassium or sodium cyanide can be prepared from this crude product.

Bucher process.—This process, the fundamental chemistry was developed by Prof. Bucher, of Brown University, is the only process of fixing nitrogen in the form of cyanides which up to the present time (1918) has shown any great possibilities of commercial success. The process is based on the fact that when sodium carbonate (soda-ash), ground coke, or carbon in any form, in contact with finely divided iron are heated to redness and nitrogen or even air passed through the mass, the nitrogen is fixed as sodium cyanide. This combination takes place readily and from a chemical standpoint the process is a success.

Prior to our entrance into the war the commercial development of this process was undertaken by the Nitrogen Products Co., which erected an experimental plant at Saltville, Va. A large plant, capable of producing 10 tons of sodium cyanide a day, has just been completed (November, 1918) by the Bureau of Mines, for the War Department, as one of the series of plants built in connection with gas warfare. This process appears to be more rational for making cyanides than the methods which have been in commercial use, and with all of the engineering difficulties solved it may be expected to replace the older methods and make sodium cyanide available at a lower price and in quantities limited only by the demand.

The cyanide produced by this process can be easily converted into ammonia and nitric acid for war demands and there is produced simultaneously sodium formate, which is the basic raw material of the formic and oxalic acid industries.

Yellow prussiate of potash—Production in United States—Official source.

[From Federal Census.]

The production was listed under "All other" for years 1899 and 1904. (See following table.) In 1909 it amounted to 3,510,208 pounds, value $463,983; and in 1914, 3,204,684 pounds, value $451,092.

All other cyanides [1]—Production in United States.

[From Federal Census.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1900 [2]	8,482,687	$1,595,505	1909	9,780,872	$1,477,910
1904 [2]	11,196,318	1,710,823	1914	13,245,541	1,947,582

[1] All other cyanides, sodium cyanide, metallocyanides, yellow prussiate of soda, trisalytes, and potassium cyanide.
[2] Includes all cyanides, no separation made for these years.
Number of establishments manufacturing cyanides: 1899, 18; 1904, 11; 1909, 7; 1914, 6.

Sodium ferrocyanide (yellow prussiate)—Production in United States

[From Geological Survey.]

Year.	Quantity.	Value.
	Short tons.	
1917	4,173	$2,577,667
1918	4,525	2,690,110
1919	3,437	1,346,285

Cyanide of potassium—Imports by countries (fiscal years). [1]

Imported from—	1912		1913		1914 [2]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	2,291,719	$343,749	777,441	$117,101	167,830	$25,437
England	284,979	41,973	231,454	29,495	49,616	7,806
All others	80,481	29,956	.....	.....	.....	.....
Total	2,757,179	410,778	1,008,895	146,596	217,446	33,243

Imported from—	1914 [3]		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	460,042	$59,360	179,972	$28,710	25	$35
England	130,561	20,470	55,924	9,519	10,080	1,801
Austria-Hungary	.....	.....	709,797	104,575	.....	.....
Canada	672	126	775,227	16,451	.....	.....
All other	.....	.....	54,797	4,473	[4] 33,600	7,475
Total	591,275	79,956	1,775,717	163,728	43,705	9,311

[1] Not listed separately previous to 1912.
[2] From July 1 to Oct. 3, 1913.
[3] From Oct. 4, 1913, to June 30, 1914, due to change in duty, placed on the free list after Oct. 3, 1913.
[4] Mexico.

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Cyanide of potassium—Imports by countries (fiscal years)—Continued.

Imported from—	1917	
	Pounds.	Value.
Sweden	8,000	$3,295
England		
Canada	6,730	2,074
Mexico	17,077	19,164
Japan	72,772	51,675
All other		
Total	104,579	76,208

Cyanide of soda—Imports by countries (fiscal years).[1]

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	5,755,169	$879,302	515,170	$78,732		
England	25,312	4,596	123,200	26,123	29,457	$9,574
Scotland	44,800	9,961			452,760	166,079
Canada			20,608	4,975	177,363	118,366
Mexico	227,178	38,867	18,500	3,863	38,983	12,821
Salvador					361,055	147,819
Brazil					227,311	38,059
Japan					562,463	345,659
All other	11,200	1,628			42,758	7,902
Total	6,063,659	934,354	677,478	113,693	1,892,150	846,279

Imported from—	1918	
	Pounds.	Value.
England	26,300	$8,517
Scotland	22,400	7,840
Salvador	25,650	17,920
All other	10,302	5,128
Total	84,652	39,405

[1] Not listed separately previous to 1915.

Imports of sodium cyanide for consumption in the United States—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1914	Free	7,856,611	$1,120,789		$0.143	
1915	do	6,187,418	955,907		.154	
1916	do	684,198	115,186		.168	
1917	do	1,875,824	861,777		.459	
1918	do	84,652	39,405		.465	
Calendar year:						
1918	do	69,279	12,615		.182	
1919	do	5,174,831	305,426		.059	
1920 (6 months)	do	3,553,144	435,161		.122	

Imports of sodium cyanide for consumption in the United States—Revenue—Continued.

CYANIDE OF POTASSIUM.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1908	12½ per cent	3,328,375	$494,915	$61,864	$0.149	12.50
1909	do	2,752,983	386,354	48,294	.140	12.50
1910	do	2,422,667	328,146	41,018	.135	12.50
1911	do	2,325,289	326,972	40,871	.141	12.50
1912	do	2,095,541	312,777	39,097	.149	12.50
1913	do	950,890	137,535	17,191	.145	12.50
1914	do	231,312	35,648	4,456	.154	12.50
1914	Free	1,005,487	147,611		.147	
1915	do	747,627	143,331		.191	
1916	do	43,705	9,311		.213	
1917	do	70,147	49,513		.705	
1918	do	13,455	3,150		.234	
Calendar year:						
1918	do	24,280	10,278		.423	
1919	do	1,176,345	68,848		.058	
1920 (6 months)	do	4,430,602	386,195		.087	

SODIUM FERROCYANIDE (YELLOW PRUSSIATE OF).

Fiscal year:		*Pounds.*				*Per cent.*
1910	25 per cent	168,404	$10,124	$2,531	$0.060	25.00
1910	2 cents per pound	1,131,436	66,560	22,628	.059	34.00
1911	do	1,196,661	66,971	23,933	.056	35.74
1912	do	1,646,344	90,654	32,926	.055	36.32
1913	do	1,887,369	118,475	37,747	.063	31.86
1914	do	430,015	30,698	8,600	.071	28.02
1914	¾ cent per pound	1,865,709	141,133	13,992	.076	9.91
1915	do	1,529,958	120,477	11,474	.078	9.52
1916	do	527,130	136,250	3,953	.258	2.90
1917	do	175,980	96,592	1,319	.548	1.37
Calendar year:						
1918	do	271,063	98,505	2,033	.363	2.06
1919	do	1,299,521	218,222	9,746	.168	4.47
1920 (6 months)	do	1,337,147	229,021		.171	

POTASSIUM PRUSSIATE, YELLOW.

Fiscal year:		*Pounds.*				*Per cent.*
1908	4 cents per pound	820,583	$88,637	32,823	$0.108	37.03
1909	do	1,754,377	178,744	70,175	.102	39.26
1910	do	2,330,871	229,907	93,234	.098	40.55
1911	do	1,777,313	180,584	71,092	.102	39.37
1912	do	2,072,761	203,295	82,910	.098	40.78
1913	do	2,812,408	309,302	112,496	.110	36.37
1914	do	521,244	58,455	20,849	.112	35.67
1914	1½ cents per pound	2,986,984	331,566	37,337	.111	11.26
1915	do	2,316,736	255,711	28,959	.110	11.32
1916	do	44,156	31,651	551	.716	1.74
1917	do	41,128	32,251	514	.784	1.59
1918	do	134,638	111,096	1,682	.825	1.51
Calendar year:						
1918	do	129,441	112,729	1,618	.875	1.44
1919	do	515,236	122,372	6,440	.236	5.26
1920 (6 months)	do	637,011	69,610		.109	

POTASSIUM PRUSSIATE, RED.

[Under general tariff.]

Fiscal year:		*Pounds.*				*Per cent.*
1908	8 cents per pound	52,149	$10,697	$4,171	$0.205	39.02
1909	do	77,255	13,522	6,180	.175	45.71
1910	do	65,777	12,460	5,262	.189	42.23
1911	do	55,082	10,230	4,406	.186	43.07
1912	do	71,612	11,264	5,728	.157	50.86
1913	do	65,316	11,302	5,225	.173	46.23
1914	do	4,873	835	389	.171	46.69
1914	2 cents per pound	85,103	14,490	1,702	.170	11.75
1915	do	83,574	14,922	1,671	.178	11.20
1916	do	2,040	3,182	40	.155	1.28
1917	do	4,523	10,425	90	.230	.87
1918	do	9,924	18,495	198	.186	1.07
Calendar year:						
1918	do	15,516	29,201	310	1.881	1.06
1919	do	34,007	18,096	680	.532	3.76
1920 (6 months)	do	55,559	37,798		.680	

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Prussiates of potash and soda, prices (wholesale), spot, New York, per pound.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916
Prussiate of potash, yellow;					
January	$0.13 -$0.13½	$0.18 -$0.22	$0.13¾	$0.22 -$0.24	$0.90-$1.00
April	.13 - .13½	.16½- .19	$0.13 - .13.1	.41 - .45	1.75 -1.80
July	.14	.16 - .18	.12½- .12¾	.80 - .90	1.20 - 1.30
October	.18 - .20	.16 - .18	.36 - .38	.82½- .85	.65 - .70
Prussiate of potash, red:					
January	.26 - .30	.33	.23	.55	5.00
April	.26 - .30	.33	.21½	.80	.....
July	.26 - .30	.33	.21 - .23	1.25	2.75 - 2.90
October	.28 - .32	.33	.75	2.50	1.75 - 2.00
Prussiate of soda:					
January	.08½- .08¾	.12	.10½	.14 - .16	.67½- .70
April	.08½- .08¾	.11 - .12	.09½- .09¾	.12	1.20 - 1.25
July	.08¾	.11 - .12	.09½- .09¾	.35 - .40	.90 - .92
October	.09½- .10½	.10½- .10¾	.20 - .22	.41 - .45	.45 - .55

	1917	1918	1919	1920
Prussiate of potash, yellow:				
January	$0.91-$0.95	$1.25 -$1.30	$0.75-$0.80	$0.36 -$0.38
April	.92- .95	1.25 - 1.27	.45 - .50	.35 - .38
July	1.00- 1.10	1.05 - 1.10	.25 - .30	.34 - .36
October	1.25- 1.30	.90 - 1.00	.45 - .55	.37 - .38
Prussiate of potash, red:				
January	2.50- 3.00	2.60 - 3.00	2.00- 2.25	1.00 - 1.10
April	2.75- 2.90	2.85 - 2.90	.80- 1.00	1.00 - 1.10
July	2.75- 2.90	2.60 - 2.70	.75- .80	.85 - .95
October	2.80- 2.95	2.30 - 2.50	1.10- 1.20	.70 - .75
Prussiate of soda:				
January	.34- .36	.35 - .36	.33- .34	.24 - .24½
April	.30- .34	.36½- .37	.17- .22	.32 - .35
July	.32- .38	.60 - .63	.18- .20	.25¾- .27
October	.35- .38	.40 - .42	.19- .20	.26 - .27

Cyanides of potash and soda, prices (wholesale), spot, New York, per pound.

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916
Cyanide of potash, U. S. P.: [1]					
January	$0.20-$0.24	$0.19-$0.24	$0.19-$0.22	$0.25-$0.26	.....
April	.20- .24	.19- .24	.19- .22	[2] .18- .25	[2] $0.37-$0.38
July	.20- .24	.19- .24	.19- .22	[2] .25- .29	[2] .37- .38
October	.19- .24	.19- .24	.25- .30	[2] .25- .29	1.00- 1.20
Cyanide of soda: [3]					
January	.....	.....	.....	.....	.25- .29
April	.....	.....	.....	.....	.40
July	.....	.....	.....	.....	.40
October	.....	.....	.....	.....	.45- .55

	1917	1918	1919	1920
Cyanide of potash, U. S. P.: [1]				
January	$2.25 -$2.30	$0.60-$0.70	$0.60-$0.70	[2] $0.25-$0.26
April	2.00 - 2.10	.60- .70	[2] .25- .26	[2] .25- .26
July	2.25 - 2.30	.60- .70	[2] .25- .26	[2] .25- .26
October	2.25 - 2.50	.60- .70	[2] .25- .26	[2] .25- .26
Cyanide of soda: [3]				
January	1.90 - 2.00	.37- .45	.30- .40	.28- .30
April	.85 - 1.05	.40- .41	.30- .35	.25- .28
July	.55 - .60	.37- .40	.26- .30	.28- .30
October	.57½- .60	.30- .40	.28- .30	.32- .35

[1] Prices are for U. S. P. product after October, 1916.
[2] Cyanide mixture, probably potassium and sodium cyanides.
[3] Not listed prior to 1916.

Rates of duty.

PRUSSIATE OF SODA.

[Not specifically mentioned prior to the act of 1909.]

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1909	73	and yellow prussiate of soda	2 cents per pound.
1913	67	Soda: * * * , and yellow prussiate of	¼ cent per pound.

CYANIDE OF SODA.

[Not specifically mentioned prior to the act of 1913.]

1913	605	Soda, cyanide of	Free list.

PRUSSIATES OF POTASH.

1883	A	Potash, prussiate of:	
		Red	10 cents per pound.
		Yellow	5 cents per pound.
1890	73	Potash, prussiate of:	
		Red	10 cents per pound.
		Yellow	5 cents per pound.
1894	57	Potash, prussiate of, red or yellow	25 per cent ad valorem.
1897	66	Potash, prussiate of:	
		Red	8 cents per pound.
		Yellow	4 cents per pound.
1909	64	Prussiate of potash:	
		Red	8 cents per pound.
		Yellow	4 cents per pound.
1913	64	Potash, prussiate of:	
		Red	2 cents per pound.
		Yellow	1½ cents per pound.

CYANIDE OF POTASH.

[Not specifically mentioned prior to act of 1897.]

1897	66	Cyanide of potassium	12½ per cent ad valorem.
1909	64	....do	Do.
1913	580	Potash, cyanide of	Free list.

Court and Treasury Decisions.

Sodium cyanide was held dutiable under the provision in the act of 1909 for alkalies, chemical compounds, and salts.—Abstract 29108 (T. D. 32681). (See cyanide of potash on the preceding page.)

Cyanide of potassium was held dutiable as a chemical salt not derived from coal tar under paragraph 60 of the act of 1897, and not exempt from duty as a coal-tar product or preparation under paragraph 443.—G. A. 3681 (T. D. 17633).

A mixture of cyanide of potassium and cyanide of sodium, known commercially as cyanide of potassium, was held dutiable as cyanide of potassium under paragraph 66 of the act of 1897 and not as a

chemical salt, the provision being construed as not limited to the pure potassium cyanide.—G. A. 4777 (T. D. 22521).

This decision was followed under the act of 1909, notwithstanding the Government's contention that paragraph 3 of that act applied only to the pure cyanide of potassium used in medicine, as by virtue of the pure-food law the impure article is not permitted to be labeled or sold as cyanide of potassium.—Abstract 23365 (T. D. 30645); followed in abstract 23593 (T. D. 30733); abstract 24026 (T. D. 30969); abstract 24475 (T. D. 31165); abstract 24568 (T. D. 31207); abstract 27170 (T. D. 32021); abstract 30514 (T. D. 32943); also abstract 35678 (T. D. 34468).

An article containing 22 per cent of cyanide of potassium, 57 per cent of cyanide of sodium, and 21 per cent of other substances, was held on the testimony to be commercially cyanide of potassium within paragraph 64 of the act of 1909, and therefore dutiable at 12½ per cent ad valorem and not at 25 per cent under paragraph 3 as a chemical compound, mixture of salt.—Abstract 29723 (T. D. 32823); abstract 30109 (T. D. 32858); G. A. 7571 (T. D. 34495); abstract 36943 (T. D. 34933). But a substance composed of 10 per cent cyanide of potash and the balance cyanide of soda, classified as a *chemical compound* under paragraph 3 of the act of 1909, was held not to be dutiable as cyanide of potassium under paragraph 64. (Abstract 36046, T. D. 34609, of 1914.)

G. A. 7571 (T. D. 34495) supra was also followed under the act of 1913.—Abstract 37164.

EXPORTS OF FOREIGN COUNTRIES.

Potassium and sodium cyanides.

GERMANY.

Year.	Short tons.	Value.
1909	6,926	$1,943,984
1910	6,975	1,957,788
1911	7,225	2,042,040
1912	7,405	2,246,958
1913	7,361	2,196,978

UNITED KINGDOM.

Year.	Short tons.	Value.
1909	8,160	$2,844,698
1910	8,700	3,082,096
1911	9,450	3,320,243
1912	9,330	3,276,692
1913	7,886	2,736,092
1914	8,990	3,345,315
1915	12,575	5,185,402
1916	13,669	5,777,616

NOTES ON THE GERMAN INDUSTRY.

The following statistics of the German cyanide industry were taken from Die Technologie der Cyanverbindungen by Dr. Wilhelm Bertelsmann:

Production of potassium ferrocyanide.

	Pounds.		Pounds.
1900	3,527,360	1903	4,850,120
1901	3,968,280	1904	5,511,500
1902	5,070,580		

Average yearly price of products (per pound).

	Potassium ferrocyanide.	Sodium ferrocyanide.	Potassium cyanide.	Sodium cyanide.
1900	$0.145	$0.105	$0.240	.....
1901	.107	.081	.201	.....
1902	.102	.080	.192	.....
1903	.096	.075	.168	$0.146
1904	.098	.075	.160	.145

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HYDROSULPHITES AND SULPHOXYLATES.

General Information.

Not specially mentioned; presumably included under paragraph 5, act of 1913:

Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof, not specially provided for in this section, 15 per centum ad valorem.

DESCRIPTION.

Under this heading is included several chemically related energetic reducing agents used chiefly in the textile trade in certain dyeing, printing, and bleaching operations, in which they are of fundamental importance. They are marketed as gray to white lumps or powders, soluble in either water or water containing acid or alkali. Chemically they include anhydrous sodium hydrosulphite, with its formaldehyde compounds, which are stable at elevated temperature, formaldehyde zinc compounds and mixtures with zinc oxide, anthraquinone and dimethylphenyl benzyl ammonium compounds, and other substances.

USES.

The general uses of the hydrosulphites include, in addition to the major application in textile trade, the following: For bleaching soaps, oils, sugar syrups, cocoa fiber, horse hair, straw, and in the preparation of pharmaceuticals and for chemical analyses.

In the textile trade the different products have the following uses:

Hydrosulphite (hydrosulphite of soda, anhydrous) is used for reducing indigo and the different vat dyes preparatory to the dyeing operation.

Sulphoxylate of soda formaldehyde, with or without the addition of other agents, is used for the "discharge" of dyes and for the application of vat colors in textile printing. The above compound, with the addition of zinc oxide, is used for discharging dyes in wool printing. The double compound of sulphoxylate of soda, formaldehyde and bisulphite of soda formaldehyde, is used for discharges on dyed cotton.

Basic sulphoxylate of zinc formaldehyde is used for stripping dyes from colored fabrics.

The leucotropes are used in discharge work on indigo dyed fabrics, the O brand for orange and the W brand for white discharges. These products are commercially of lesser importance. They are the only coal-tar derivatives in this entire class.

DOMESTIC PRODUCTION.

There are at present three manufacturers in the United States. The raw materials used in the manufacture of these products are all

from domestic sources and available in adequate amounts at a reasonable cost. The equipment is of special design and has been designed by manufacturers.

Method of production.—Sodium hydrosulphite is prepared by dissolving in a closed tank, at a fixed temperature, zinc in a solution of sodium bisulphite with the addition of sulphur dioxide. The zinc is later recovered as zinc oxide by treatment with lime. The hydrosulphite may be separated from the solution by "salting out" (addition of salt, calcium chloride or magnesium chloride). The hydrous salt ($Na_2S_2O_4 2H_2O$) is very unstable; by treatment with hot alcohol the anhydrous form is obtained which is comparatively stable ($Na_2S_2O_4$).

The anhydrous hydrosulphite is unsuitable for "discharge" work in calico printing as it is oxidized in steaming. The formaldehyde compounds overcome this difficulty as their solutions are stable in the air, yet at elevated temperatures decompose with a powerful reducing reaction. The formaldehyde compound with hydrosulphite is made by combining hydrosulphite with formaldehyde or by reduction of the aldehyde bisulphite compound with zinc. The formaldehyde sodium sulphoxylate is prepared by reduction of formaldehyde hydrosulphite or formaldehyde bisulphite with zinc, or through fractional crystallization of formaldehyde hydrosulphite, or by the action of caustic soda on a mixture of hydrosulphite and formaldehyde. The solid product is obtained by vacuum evaporation.

The leucotropes are certain quaternary ammonium bases. The leucotrope O is dimethylphenylbenzylammonium chloride, and leucotrope W is dimethylphenyl benzylammonium calcium sulphonate. They are made by condensing dimethylanilin, benzyl chloride with subsequent treatment with sulphuric acid for the W type, although this may be carried out before the products are combined.

The manufacture of these different products requires unusual care with the highest class of labor and technical supervision.

Organization.—The production of hydrosulphites and sulphoxylates constitutes one of the several lines of chemical products made by the three domestic producers: Rohm & Haas, of Philadelphia, Pa.; Merrimac Chemical Works, of Boston, Mass., and Jacques Wolffe, of Passaic, N. J.

History of the industry.—Prior to the war the supply of solid hydrosulphites and sulphoxylates was imported from Europe, Germany being the chief producer. Certain plants made liquid hydrosulphite for indigo dyeing from zinc dust and bisulphite of soda. The war shut off the German supply, compelling the printing and dyeing establishments to make liquid hydrosulphite and sulphoxylate solutions. Rohm & Haas was the first domestic producer, followed by Jacques Wolffe and the Merrimac Chemical Co.

Domestic production and consumption.—Information in possession of the Tariff Commission indicates that the capacity of the domestic plants exceeds that of the 1914 imports of these products; during and prior to 1914, our supply of solid hydrosulphites and sulphoxylates was of European manufacture.

Domestic exports.—Hydrosulphites and sulphoxylates of domestic manufacture have not been exported in significant amounts.

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FOREIGN PRODUCTION.

Germany, the first producer and largest manufacturer of these products, sold them with her dyes. The German dye makers held an advantageous position in regard to the sale of hydrosulphites and sulphoxylates and successfully met any competition as these chemicals were essential in application of their dyes.

France and England were also producers. Since the war England has greatly increased her output and has entered the domestic market.

IMPORTS.

In 1913–14 fiscal year, 871,000 pounds of hydrosulphites and sulphoxylates were imported, valued at $288,061. In addition, 800 pounds of leucotropine, valued at $253, were imported. The following table from "Chemical and Allied Products Used in the United States," Department of Commerce, miscellaneous series No. 82, gives further detail on these imports for 1914.

Import of hydrosulphite of soda and preparations, fiscal year 1913–14.

Article.	Pounds.	Value.	Average price.	Source.
Hydrosulphite of soda	505,232	$116,197	$0 23	Germany, 100 per cent.
Hyraldite	7,723	18,077	2.34	France, 78.1 per cent; Germany, 21.9 per cent.
Rongalite	341,704	89,482	.26	Germany, 96 per cent; Belgium, 2.6 per cent; England, 1.4 per cent.
Decroline	17,041	4,305	.253	Germany, 100 per cent.
Total	871,700	228,061		
Leucotropin	800	253	.316	Germany.

Hydrosulphites of German and English manufacture were imported in increasing amounts during the fall of 1920. In November, 1920, 70,160 pounds of soda hydrosulphite were reported according to the weekly statements of the Oil, Paint, and Drug Reporter. This does not include 10 casks of unreported weight.

PRICES.

Market quotations are not given on these products. Prior to the war hydrosulphite of German origin sold for 25 to 35 cents per pound, depending on the quantity. The dutiable value in 1913–14, fiscal year, is given as 23 cents. It is reported that lots were sold for 13 cents a pound in certain cases in conjunction with large lots of synthetic indigo. During the war scarcity the price reached $3 and then gradually receded to $1.25 in 1920.

In the fall of 1920 domestic hydrosulphite sold from 65 to 85 cents per pound; this figure was later reduced to 55 cents per pound. Hydrosulphite of German manufacture was offered in the early part of December, 1920, at 70 cents per pound; later this was reduced to 55 cents per pound. During the same month hydrosulphite of English make was offered at 70 cents in the first part and at 50 cents per pound in the latter part of December.

Leucotrope W sold before the war for about 40 cents per pound. The same product of domestic manufacture sold in the latter part of 1920 from $1.25 to $1.75 per pound. The dutiable value of the lecutropin imports for the fiscal year 1913–14 is given as 31.6 cents per pound.

TARIFF HISTORY.

Hydrosulphites and sulphoxylates are not specifically mentioned in the tariff act of 1913. They are presumably included under paragraph 5:

> Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures, and salts, and combinations thereof, not specially provided for in this section, 15 per centum ad valorem.

In House report 8078, Group II: "Dimethylphenylbenzyl ammonium hydroxide" * * * "or any sulphoacid or sulphoacid salt of any of the foregoing" would include leucotrope W and O, which are both coal-tar derivatives.

COMPETITIVE CONDITIONS.

Prior to the war Germany was the world's chief producer of hydrosulphites and sulphoxylates and successfully sold these products in face of competition, in conjunction with her dyestuffs. Germany has the advantage of experience in the manufacture of these compounds over an extended period of time.

In the latter part of 1920 German and English made hydrosulphites were offering serious competition to the domestic made products. It is reported that the English sellers were instructed to capture the hydrosulphite business in this country at any cost.

Domestic producers report that under the competition offered during December they do not know how much longer they can continue productions of these products.

TARIFF CONSIDERATIONS.

The "hydrosulphites and sulphoxylates" are not specifically mentioned. These are essential for the textile industry for many printing and dyeing operations. Manufacturers report that competition offered by the imported products threatens this industry.

In the Summary of Tariff Information, 1920, page 131, it was pointed out that separate provision might be made for these products in a paragraph following paragraph 67, in these words "Sodium hydrosulphite, hydrosulphite compounds, sulphoxylate compounds, and all combinations and mixtures (rate)."

The leucotropes, commercially of less importance yet of great value to the printing trade, are derived from coal tar and are included in House Report 8078, Group IV.

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Brand names and composition.

Trade name.	Maker.	Composition.	Uses.
1. Formopon	Rohm & Haas, Philadelphia, Pa.	Sulphoxylate of soda-formaldehyde ($NaHSO_2+CH_2O+2H_2O$).	Discharges on dyed cotton.
2. Hydrosulphite	Jacques Wolf & Co., Passaic, N. J.		
3. Formosol	Brotherton (Ltd.), Leeds, England.		
4. Rongalite	B. A. S. F., Germany		
5. Hydrosulphite NF conc.	Hoechst, Germany		
6. Hyraldite C extra	Cassella, Germany		
7. Rongalite CW	B. A. S. F., Germany	Same product as 3, 4, and 5, but with addition of zinc oxide.	Discharges on wool.
8. Hydrosulphite NFW, conc.	Hoechst, Germany		
9. Hyraldite CW, extra.	Cassella, Germany		
10. Rongalite C, simple.	B. A. S. F., Germany	The double compound of sulphoxylate of soda-formaldehyde and bisulphite of soda-formaldehyde ($NaHSO_2+CH_2O+2H_2O+NaHSO_2+CH_2O+H_2O$).	Discharges on cotton.
11. Hydrosulphite NF.	Hoechst, Germany		
12. Hyraldite A	Cassella, Germany		
13. Rongalite CW, simple	B. A. S. F., Germany	Same product as 10, 11, and 12, but containing an addition of zinc oxide.	Discharges on wool.
14. Hydrosulphite NFW.	Hoechst, Germany		
15. Hyraldite W	Cassella, Germany		
16. Rongalite, special	B. A. S. F., Germany	Same as 3, 4, and 5, but with an addition of a catalytic agent, such as Induline scarlet.	Discharges on cotton.
17. Hydrosulphite NF, spec. conc.	Hoechst, Germany		
18. Hyraldite, special	Cassella, Germany		
19. Formopon, extra	Rohm & Haas, Philadelphia, Pa.	The basic sulphoxylate of zinc-formaldehyde, insoluble in water, but soluble in acetic acid ($ZnOH)HSO_2+CH_2O$.	Stripping colors.
20. Zinc formosol	Brotherton (Ltd.), England		
21. Decroline	B. A. S. F., Germany		
22. Hydrosulphite AZ	Hoechst, Germany		
23. Hyraldite Z	Cassella, Germany		
24. Lykopon	Rohm & Haas, Philadelphia, Pa.	Anhydrous hydrosulphite of soda.	For dyeing indigo and vat dyes.
25. Hydrosulphite	Merrimac Chemical Co., Boston.		
26. Hydrosulphite conc.	B. A. S. F., Germany		
27. Leucotrope W (equivalent).	Rohm & Haas, Philadelphia, Pa.	Dimethylphenylbenzylammonium disulphonic acid calcium salt.	Indigo discharges (white).
28. Leucotrope W	B. A. S. F., Germany		
29. Leucotrope O (equivalent).	Rohm & Haas, Philadelphia, Pa.	Dimethylphenylbenzylammonium chloride.	Indigo discharges (orange).
30. Leucotrope O	B. A. S. F., Germany		
31. Rongalite CL	B. A. S. F., Germany	Leucotrope W and Rongalite C.	Indigo discharges.
32. Hydrosulphite CL	Hoechst, Germany	Leucotrope W and hydrosulphite NF.	
33. Hydralite CL	Cassella, Germany	Leucotrope W and hydrolite A.	
34. Indigolite	Jacques Wolf & Co., Passaic, N. J.	Leucotrope W. Sulphoxylate of soda-formaldehyde.	

SODIUM HYDROXIDE [CAUSTIC SODA].

[Par. 67, act of 1913. One-fourth cent per pound.]

SUMMARY.

Description.—Caustic soda (sodium hydroxide) is one of the strongest alkalis, and in industrial importance ranks second only to soda ash. The commercial product is sold on a basis of the content of actual alkali (Na_2O). The usual grades are 60, 70, 74, and 76 per cent. Caustic soda has a wide variety of uses, the chief of which are the manufacture of soap, wood pulp and paper, chemicals, dyes, and drugs.

Domestic production.—The production of caustic soda has more than doubled since 1914. During 1917 there was produced 468,363 short tons, valued at $29,733,673. This great increase is due to the war demand, principally in the manufacture of the military explosive picric acid. Our consumption is supplied almost wholly by the domestic production.

Caustic soda is produced by two processes, the Solvay process (causticization of soda ash), and the electrolytic process. About 30 per cent is produced by the electrolytic process and the remaining 70 per cent by the Solvay process.

Exports of caustic soda are not shown separately in Commerce and Navigation until the 1918 fiscal year, when 134,729,691 pounds, valued at $8,629,086, were exported. A large part of this export was to South American countries, Japan, and Italy.

Foreign production.—The exports of the United Kingdom prior to the war amounted to about 84,000 short tons annually. Germany exported about 12,000 tons per year. Great Britain controlled a large part of the trade in caustic soda, principally in South American countries. The prolongation of the war and the enforcement of an absolute prohibition of exportation have made it impossible for the British companies to keep up their trade. As a result the United States is now (1918) the only source of supply for the South American markets.

Imports.—The greatest importation of caustic soda was in 1911, when about 1,500 tons were brought in. Since then the imports fell off until in 1917 only 50 tons were imported.

Prices.—The war has caused a great increase in the price of caustic soda. The maximum was reached in the latter part of 1917, when the prevailing price was about 10 cents per pound, this being an increase of about 400 per cent over the prewar price. At the present time (May 27, 1918) the price of caustic soda is about 4 cents per pound, an increase of 100 per cent over prewar prices.

Tariff history.—Caustic soda has been assessed a specific duty, which has been between 1 cent per pound and the present duty of ¼ cent per pound, paragraph 67 of the tariff act of 1913.

LIBRARIES

Caustic soda—Summary table.

	Domestic[2] production.	Imports for consumption.	Domestic exports.
Fiscal year—	*Short tons.*	*Short tons.*	
1910	134,228	519	.....
1911	155,059	1,492	.....
1912	173,183	465	.....
1913	180,917	336	.....
1914	212,539	332	.....
1915	287,239	222	.....
1916	391,597	112	.....
1917	468,363	55	.....
1918	513,363	53	67,365
1919	355,466	1/1000	.....
Calendar year—			
1918	.....	1	48,689
1919	.....	21	82,112
1920[1]	.....	37	84,533

	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
Fiscal year—				*Per cent.*
1910	$2,544.00	$555.00	$0.034	21.84
1910	31,338.00	4,823.00	.032	15.39
1911	73,968.00	14,921.00	.025	20.17
1912	28,937.00	4,653.00	.031	16.06
1913	25,363.00	3,357.00	.038	13.24
1914	17,283.00	1,175.00	.037	6.80
1915	19,318.00	1,110.00	.043	5.75
1916	20,981.00	562.00	.083	2.68
1917	21,052.00	275.06	.191	1.31
1918	9,591.00	264.00	.091	2.75
1919	2.00	.....	1.000	.....
Calendar year—				
1918	193.00	5.00	.096	2.59
1919	6,888.00	107.00	.161	1.55
1920[1]	7,954.00	186.00	.106	2.33

[1] First 6 months of calendar year. [2] Calendar year.

General Information.

DESCRIPTION.

Caustic soda (sodium hydroxide or sodium hydrate) is one of the strongest alkalies known and in industrial importance ranks second only to soda ash as an alkali. It is a white, opaque solid having strong caustic properties. It is fusible below a red heat and is less volatile than the similar potassium compound. It is very soluble in water and is very deliquescent. Carbon dioxide converts it into sodium carbonate (soda ash). Solutions of caustic soda dissolve hair, wool, most animal substances, also sulphur, metallic sulphides, and silica. Caustic soda also saponifies oils and fats, forming soaps. This gives caustic soda its most important industrial use.

Chemically caustic soda is composed of 77.5 per cent of sodium oxide (Na_2O) and 22.5 per cent of water (H_2O). It has the chemical formula NaOH. The commercial product is sold on the percentage content of sodium oxide, and the common grades are 60, 70, 74, and 76 per cent.

The same wide divergence exists in the methods of stating the purity and strength of caustic soda as exists in stating the purity of soda ash. The method of stating the strength of caustic soda, outside

of Germany and France, is based on the percentage content of sodium oxide or alkali. Caustic soda, however, became an article of commerce while chemical science was in its infancy. At an early date a method of computing the composition of caustic soda from its chemical analysis was adopted, based on chemical equivalents that were then generally accepted as being correct. This test was called the "Newcastle test." The advance of chemical science has since proven this test to be in serious error, but this old erroneous method has persisted in commercial use. The persistence of this erroneous method in England may be ascribed partly to the conservatism of the English business man and partly to the fact that the method overstates the purity of the product. This "Newcastle test" is still generally used in England. At a later date the so-called "New York and Liverpool test" was devised. This test, however, is even more irrational than the "Newcastle test," and at its time of invention must have been known to be in error. This method overstates the purity and quality even more than the "Newcastle test," which may account for its introduction. This method has been commonly used in the export trade of England and thus came into use in the United States. In this country caustic soda is sold on the New York and Liverpool equivalent test figured from the actual alkali (Na_2O) determined by chemical analysis and based on modern knowledge of chemical equivalents. In Germany caustic soda is sold on a basis of the alkali content expressed in terms of an equivalent per cent of sodium carbonate (soda ash). In France it is sold according to Descroizille's degrees, which give the strength of the caustic soda in per cent of sulphuric acid chemically equivalent to the alkali content.

On the whole the most rational and desirable basis would seem to be to report and quote the strength of caustic soda in terms of the percentage content of actual alkali (Na_2O) based on the modern chemical equivalents. However, if a definite test is specified and the buyer and seller thoroughly understand the test, there should be no trouble or confusion in commercial transactions.

The following table shows the different values that may be obtained for the same grade of caustic soda according to the method used in calculating the chemical analysis. The grades taken for illustration are the ones common to the trade.

Actual alkali, sodium oxide, Na_2O.	Newcastle, sodium oxide, Na_2O.	New York and Liverpool, sodium oxide, Na_2O.	German degree, sodium carbonate, Na_2CO_3.	French degree, sulphuric acid, H_2SO_4.	Actual caustic, NaOH.
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
60	60.79	61.93	102.58	94.84	77.4
70	70.92	72.26	119.69	110.64	90.3
74	74.97	76.39	126.52	116.97	95.48
76	77.60	78.45	129.94	120.13	98.06

IMPORTANT USES.

Caustic soda has a wide variety of uses, the chief of which are for the manufacture of soap, wood pulp and paper, chemicals, dyes, and drugs. It is also used in the refining of vegetable and mineral oils, in the textile industries, in the mercerizing of cotton, water softening, bottle washing, and in the preparation of cleaners.

LIBRARIES

The largest normal use for caustic soda is in the manufacture of soap. At the present time, however, there is a large demand for caustic soda in the manufacture of phenol, which is one of the raw materials for the important military explosive, picric acid. In addition, the establishment of a dye industry in this country has created a new outlet for caustic soda, which at the present time constitute one of the important uses for this article.

There is a product marketed as "causticized ash," which is a mixture of caustic soda and soda ash. It is used chiefly in the brewing and dairying industries. There are three grades on the market having the following composition:

(1) 25 per cent NaOH; 75 per cent Na_2CO_3.
(2) 36 per cent, NaOH; 64 per cent, Na_2CO_3.
(3) 45 per cent, NaOH; 55 per cent, Na_2CO_3.

RAW MATERIALS.

Caustic soda is made from salt or soda ash as the raw material, depending on the method of manufacture. Since soda ash is made from salt we may consider salt as the basic raw material for the manufacture of caustic soda. If the caustic soda is made from soda ash, then lime enters into the process of manufacture as the other raw material, while if salt is used it is converted into caustic soda by the means of the electric current. All the raw materials for the manufacture of caustic soda are produced in the United States in large quantities and there is no need for their importation.

While cheap electric power is an advantage for the production of caustic soda, it is not as vitally necessary as in the case of the other electrochemical processes. There are a number of plants producing caustic soda which generate their electricity for electrolysis by means of steam installations.

PROCESS OF MANUFACTURE.

By the causticization of soda ash.—The soda ash for the manufacture of caustic soda is prepared by the "ammonia-soda" process. (See the report on soda ash). Caustic soda is produced by treating a solution of soda ash with a solution of lime commonly called "milk of lime." The lime and soda ash combine to form caustic soda and calcium carbonate. The former is soluble and remains in the solution while the latter is insoluble and is precipitated out of the solution. The precipitated calcium carbonate (lime mud) is removed from the caustic soda solution by filtration or decantation, thus leaving a clear solution of caustic soda. This process of causticizing soda ash in the manufacture of caustic soda has been developed into a continuous operation requiring very little labor and attention.

The solution of caustic soda is now concentrated in vacuum evaporators to a definite strength, when it is transferred to open cast iron pots (finishing pots), where all the water is boiled out of the caustic soda. While still hot and in the molten state it is run into sheet iron drums where it is allowed to cool and solidify. These drums are sealed at once to prevent the absorption of moisture and carbon dioxide from the atmosphere.

By the electrolysis of salt.—Caustic soda is prepared from salt in one chemical step by passing a direct current of electricity through a saturated solution of salt in a suitable apparatus known as an electrolytic cell. The salt is decomposed by the current with the formation of caustic soda and chlorine simultaneously. Depending on the type of electrolytic cell used the solution of caustic soda as it leaves the cell may or may not contain varying amounts of salt which has not been decomposed. In either case the solution is evaporated under vacuum and if salt is present in the solution it separates out during the evaporation and is returned to the process. After evaporation the process of finishing and packing the caustic soda is the same as in the process described above. At the present time (1918) about 30 per cent of the total production is manufactured electrolytically.

In the finishing of caustic soda there is a certain quantity of caustic soda at the bottom of the finishing pot which contains all the impurities. This portion in packing is ladled out of the pots last and is known to the trade as "bottoms." It is usually of a brown color and contains considerable iron oxide which has been thrown out of the caustic soda solution during the finishing process. In some cases these "bottoms" can be used instead of the pure caustic and they can be purchased at a much lower cost than an equivalent amount of pure caustic soda.

There is a small trade in liquid caustic soda when the freight haul is short and the caustic soda can be used in the liquid form, such as in the manufacture of soap. In cases of this kind the liquid caustic soda is shipped in tank cars or drums. It is evident that this method is not economical for long hauls where the freight would be excessive.

History of the industry.—The manufacture of "white solid caustic soda" which is the ordinary form extensively used in the trade, originated in England and has been developed in that country since the year 1852 as a part of the LeBlanc soda process. This process, however, has not been introduced into the United States, and it was not until 1881, after the successful operation of the Solvay ammonia-soda process, that the caustic soda industry was established in this country. From this time until 1897 the caustic soda manufactured in the United States was made from soda ash, which was produced by the "ammonia-soda" process. In 1897 electrolytic caustic soda was first manufactured in this country by two different companies. Since this time the electrolytic caustic soda industry has developed rapidly up to a limit established by the quantity of chlorine products that can be disposed of on the market.

The scarcity of ocean shipping caused by the European war forced England to abandon the exportation of caustic soda. This resulted in the markets which England formerly held being thrown open to the manufacturers of the United States. These markets are located chiefly in South America and at the present are being supplied by American caustic soda. War conditions in general have resulted in a large increased production of caustic soda in this country.

The industry in 1917.—From preliminary press notice of the Geological Survey, August 4, 1918.

In 1917 caustic soda was made from soda ash by 8 companies and from sodium chloride by electrolysis by 28 others, but the total production reported by the 8 companies using soda ash was 358,081 tons, valued at $21,086,766, against 137,663

tons, valued at $8,646,907, for the 28 companies using sodium chloride. Many of the firms that produce caustic soda electrolytically make pulp or paper and all utilize the chlorine produced, some selling it directly, others converting it into bleach or other products. The caustic soda produced included some dilute solutions, but after the figures reported are reduced to express actual sodium hydroxide the caustic soda produced from soda ash in 1917 amounted to 341,793 tons: that made from sodium chlorine by electrolysis amounts to 126,570, which is 27 per cent of the total sodium hydroxide made—468,363 tons. This total output shows an increase of 71,423 tons or 18 per cent, over that of 1916. Of the total output in 1917, 74,015 tons, or about 16 per cent, was consumed by the makers in their own plants, and the rest was sold. Before the European war the manufacture of electrolytic alkali was limited by the quantity of chlorine that could be utilized and the present great demand for chlorine for use in the war should permit a large increase in the production of caustic soda.

Competitive conditions.[1]—The present activities of the British alkali combination which controls a large part of the trade in caustic soda, soda ash, and allied products illustrate the efforts of such organizations to retain their hold on their trade. The principal members of this combination have been the Brunner, Mond Co. and the United Alkali Co., which in turn control a number of other companies. Late in May, 1916, it was reported that the combination had been still further strengthened by a merger between the firm of Brunner, Mond & Co. (Ltd.) and the Castner-Kellner Alkali Co. For several years the latter company was understood to be acting in harmony with Brunner, Mond & Co. (Ltd.) and the United Alkali Co. The combined capital of Brunner, Mond & Co. (Ltd.) and the Castner-Kellner Alkali Co. will be more than £8,500,000 ($42,000,000). One of the principal objects of the merger is stated to be the extension of the British foreign trade in the chemicals manufactured.

The combination is reported to have had trade agreements with German manufacturers in the same lines and to have controlled 80 per cent of the British output. Before the war it monopolized the South American trade of its various products, particularly in caustic soda, a chemical needed by soap makers. For example, in 1913 caustic soda of British origin formed 85 per cent of the total imported into Argentina and 96 per cent of the total into Brazil. Since this chemical is in great demand for war purposes, at first its exportation from Great Britain was restricted and later on absolutely prohibited. The demand for it in Europe became so great that large quantities of the American product were imported for British and allied consumption. The American price, stimulated by an increased domestic demand and an unprecedented foreign demand, both from belligerent and neutral countries, soon doubled and trebled. For a time, while their exportation was merely restricted, the British combination, in order to retain its hold on the South American trade, made sales of caustic soda to its customers there at a price substantially less than that at which the chemical was being bought for European consumption. The British manufacturers in the combination contemplated, in case the war came to an early end, being able by this procedure to hold their markets. There was no inducement for an American manufacturer to attempt to develop a market in Argentina at a time when the European market offered much higher prices. The prolongation of the war, however, and the enforcement of an absolute prohibition of exportation made it impossible for the British companies to continue their export trade. As a result the United States is to-day the only source of supply for the South American markets.

[1] Report on cooperation in American export trade, by Federal Trade Commission, June 30, 1916, p. 178.

Before the war South American soap makers demanded a certain popular British brand of caustic soda of 70° to 72° test, which was manufactured by one of the firms in the combination. This brand was so well established that it practically had a monopoly in the market. The soap makers had based their formulas on its use, and their workmen were accustomed to the use of certain measures in determining the quantity used.

The American caustic soda which they have been able to obtain has generally been 76° to 78° test. Their attempts to use it in the same manner as they were accustomed to use the lower test British brand resulted unsatisfactorily and created a prejudice against the American product. When all supplies of the British brand had been exhausted and it became absolutely necessary for the manufacturers to use the American caustic soda if they were to continue to make soap, the formulas and measures were altered, and after some experimentation perfectly satisfactory results were obtained. At first there was much trouble with the American methods of packing caustic soda for export, but this difficulty seems largely to have been overcome. Certain soap makers in the River Plata region state now that they have changed their manufacturing methods. To use the higher test caustic soda they think was a step toward a marked economy in their business, since it takes a less bulk of the American caustic than of the British brand formerly used to accomplish the same results in soap making. With the high shipping rates now prevailing, this permits a considerable saving in freight. They also state that they would prefer to continue the use of the higher test caustic soda after the war if they can get it at a suitable price. It is apparent, therefore, that the value of the British brand of 70° to 72° caustic soda, which formerly practically monopolized the market, has greatly diminished, and one obstacle in the development of trade in the American product has been largely overcome.

Agents of the British alkali combination for some time have been trying to make arrangements to shut out the American companies as soon as the British prohibition of the exportation of caustic soda is removed. For this purpose they are endeavoring to get the prominent importers to enter into contracts to handle the British product exclusively, and in consideration of this exclusive contract are guaranteeing that the British prices will be lower than any that might be offered by the Americans. Thus, the combination is preparing to use the united resources of its members in a vigorous price-cutting war against the individual American manufacturers who now have this trade.

Production of caustic soda in United States.[1]

Year.	Quantity.	Value.	Year.	Quantity.	Value
1900[1]	56,760		1910	134,228	
1901	84,730		1911	155,059	
1902	81,935		1912	173,183	
1903	94,796		1913	180,917	
1904	98,036		1914	203,391	
1905	106,391		1915	287,239	
1906	114,070		1916	391,597	
1907	112,698		1917	488,056	$29,402,689
1908	104,860		1918	513,363	31,854,470
1909	127,900		1919	355,466	22,196,898

[1] Figures for 1900 to 1915, inclusive, submitted by Solvay Process Co., Syracuse, N. Y., later figures from United States Geological Survey.

Caustic soda—Exports of the United Kingdom.

Countries.	1910		1911		1912	
	Quantity.[1]	Value.	Quantity.	Value.	Quantity.	Value.
Italy	12,269	$528,861	11,015	$449,263	11,627	$476,936
Japan and Formosa	12,763	591,341	12,509	522,886	13,082	546,053
Mexico	6,356	299,911	8,015	356,240	6,340	270,452
Brazil	6,737	321,633	6,784	300,461	8,969	388,049
United States	2,599	126,263	792	37,940	736	35,176
Argentina	6,569	280,651	5,654	229,729	6,424	246,108
Canada	5,166	193,307	4,913	174,607	5,107	157,284
Total foreign	74,062	3,301,756	71,885	3,029,066	69,477	2,875,144
Total British	18,852	888,264	18,874	831,468	18,133	808,919
Grand total	92,914	4,190,020	90,759	3,860,534	87,610	3,684,063

Countries.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Italy	10,473	$412,963	13,380	$545,347	12,707	$539,128
Japan and Formosa	12,228	502,979	14,674	586,124	6,766	273,372
Mexico	3,589	154,369	2,445	99,510	288	14,763
Brazil	7,880	344,605	6,911	290,286	6,221	367,738
United States	596	28,962	662	32,009	179	10,360
Argentina	6,954	262,380	6,406	224,712	2,946	125,509
Canada	3,504	123,407	502	17,050	35	1,873
Total foreign	66,262	2,720,109	68,252	2,746,127	47,334	2,205,724
Total British	17,634	801,625	15,079	669,289	15,201	785,207
Grand total	83,896	3,521,733	83,331	3,415,416	62,535	2,990,931

Countries.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Italy	5,844	$371,033	19,393,152	$1,118,619	.....	.....
Japan and Formosa	1,230	82,561	236,320	7,008	.....	.....
Mexico	23	2,730	.....	.....	.....	.....
Brazil	3,138	368,799	1,156,064	86,857	.....	.....
United States	45	4,175	2,352	195	.....	.....
Argentina	1,767	180,723	1,534,736	100,771	.....	.....
Canada	9	1,246	2,240	161	.....	.....
Total foreign	21,322	1,949,699	32,339,552	1,938,342	.....	.....
Total British	11,372	1,038,949	18,229,232	1,133,904	.....	.....
Grand total	32,694	2,988,649	50,568,784	3,072,246	.....	.....

[1] Quantities are in short tons of 2,000 pounds.

NOTE.—Table is taken from the official reports of the United Kingdom, the figures being converted into United States units.

Caustic soda—Exports from Germany.

Countries.	1909		1910		1911		1912		1913	
	Quantity.[1]	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value
Belgium	634	$29,512	285	$13,566	506	$22,610	364	$16,422	612	$22,372
Netherlands	426	19,754	366	17,136	467	20,944	422	18,326	290	12,376
Finland	516	24,038	332	15,708	435	18,326	336	13,804	291	11,662
Switzerland	6,033	280,126	7,547	350,574	7,400	324,870	9,144	370,328	9,176	395,318
All others	1,555	71,876	1,652	75,684	2,958	149,940	3,468	179,690	3,994	207,774
Total	9,164	425,306	10,182	472,668	11,766	536,690	13,734	598,570	14,363	649,502

[1] Quantities are in short tons of 2,000 pounds, converted from the German units.

Caustic soda or hydrate of—Imports for consumption—Revenue.

	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1909	¼ cent per pound	781,971	$24,742	$5,864	$0.032	23.70
1910	do	74,107	2,544	555	.034	21.84
1910	½ cent per pound	964,696	31,338	4,823	.032	15.39
1911	do	2,984,280	78,968	14,921	.025	20.17
1912	do	930,616	28,937	4,653	.031	16.08
1913	do	671,479	25,363	3,357	.038	13.24
1913	D. R. U. S.	1	1		1.000	
1914	½ cent per pound	194,947	6,631	974	.034	14.70
1914	¼ cent per pound	470,372	17,283	1,175	.037	6.80
1915	do	444,185	19,318	1,110	.043	5.75
1916	do	225,189	20,981	562	.093	2.68
1917	do	109,983	21,052	275	.191	1.31
1918	do	105,476	9,591	264	.091	2.75
1919	do	2	2	.01	1.000	.05
Calendar years:						
1918	do	2,002	193	5	.096	2.59
1919	do	42,724	6,888	107	.161	1.55
1920[1]	do	74,598	7,954	186	.106	2.33

[1] First 6 months calendar year 1920.

Caustic soda—Domestic exports.

Exported to—	Fiscal year.		Calendar years.			
	1918[1]		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	4,247,692	$198,017	3,922,065	$132,390	15,564	$4,101
Italy	26,159,344	2,138,407	4,959,037	376,498	5,043,522	351,607
United Kingdom	936,366	90,503			191,834	13,027
Canada	12,399,822	545,618	12,423,267	579,109	7,072,099	279,350
Mexico	4,611,240	260,602	5,380,218	298,349	10,916,733	480,301
Cuba	7,851,283	363,642	8,856,688	414,088	5,591,323	184,729
Argentina	6,974,101	334,440	5,806,845	269,698	10,434,091	450,305
Brazil	13,139,563	809,646	13,870,301	899,144	11,299,348	558,633
Chile	2,030,048	67,623	2,123,405	83,788	1,356,029	58,442
Uruguay	1,544,069	76,653	1,509,622	78,649	1,529,131	69,775
China	1,191,854	102,313	1,850,578	129,384	9,566,700	420,538
British India	3,076,298	184,826	693,125	47,630	1,946,044	71,805
Japan	35,047,567	2,498,688	19,857,155	1,381,907	70,812,545	2,499,000
Australia	2,600,479	154,841	2,533,862	111,522	2,035,096	132,461
Philippines	4,735,447	294,445	5,801,561	330,678	2,890,299	119,200
All other	8,184,518	508,822	7,790,515	467,979	23,532,962	1,055,488
Total	134,729,691	8,629,086	97,378,334	5,602,813	164,235,420	6,748,762

[1] Not listed separately prior to 1918.

NOTE.—First 6 months calendar year 1920, 169,066,976 pounds; value, $7,942,028.

Caustic soda, prices, per pound, spot, New York.

[From Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.
	Cents.	*Cents.*	*Cents.*	*Cents.*
1912	1.70–1.80	1.60–1.70	1.60–1.70	2.40–3.00
1913	2.40–3.00	2.00–2.50	2.00–2.50	2.00–2.25
1914	2.00–2.25	2.00–2.50	2.00–2.50	2.00–2.25
1915	2.00–2.25	2.25–2.50	2.25–2.50	4.00
1916	5½– 5¾	6.1– 6½		5– 5½
1917	5¾– 6	4⅜– 4½	6¾– 7	10 – 10½
1918	6½– 7	4¼– 4½	4 – 4¼	4½– 4¾
1919	4½– 4 9/16	3½– 4	3½– 3¾	3½– 3¾
1920	4.50–4.60	6.75–7.00	6.50–6.75	4.00–4.35

Caustic soda, prices per pound, f. o. b. works, domestic.

[From Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.
	Cents.	*Cents.*	*Cents.*	*Cents.*
1912	1.80–1.85	1.70–1.75	1.70–1.75	1.60–1.65
1913	1.60–1.65	1.60–1.65	1.57–1.62	1.55–1.60
1914	1.55–1.60	1.55–1.60	1.55–1.60	1.55–1.60
1915	1.55–1.60	1.70–1.80	.....	.....
1916	5½– 5¾	.....	6¼– 6¾	5 – 5½
1917	4.4 – 4¼	.....	6¾	9¾
1918	(1)	(1)	3½	3½
1919	3¼– 3½	3¼– 3½	2¾– 3¼	2¾– 3¼
1920	3¾– 4	(1)	(1).	(1)

[1] Nominal.

Caustic soda or hydrate of soda—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	A	Soda, hydrate or caustic	1 cent per pound.
1890	81	Soda, hydrate of, or caustic soda	Do.
1894	65	.....do	½ cent per pound.
1897	76	.....do	¼ cent per pound.
1909	73	Hydrate of, or caustic soda	½ cent per pound.
1913	67	Soda, hydrate of, or caustic	¼ cent per pound.

Court and Treasury Decisions.

Caustic soda, classified by the collector as an unenumerated article under the act of 1857, was held dutiable as most resembling soda ash.—Gamble *v.* Mason, 9 Fed. Cas., 1140.

A white powder invoiced as "insecticide" and claimed to be exempt from duty as caustic potash under the act of 1897, was found to be caustic soda, but not being so claimed in the protest the collector's classification of the merchandise as a chemical compound was sustained.—G. A. 4462 (T. D. 21322).

Soda lime, consisting of caustic lime and caustic soda, was held dutiable as a chemical compound under the act of 1883 and not as soda sal or soda crystal.—Appeals, T. D. 9207 and 9126.

A granulated substance composed of about 40.6 per cent of soda combined with carbonate and sulphate of soda was held dutiable under the Revised Statutes as caustic soda by similitude.—Appeal, T. D. 4118.

A solution of caustic soda and water, 37.4 per cent being soda, was likewise held dutiable under the Revised Statutes as caustic soda as the component carrying the highest rate of duty.—Appeal, T. D 4066.

SODIUM NITRATE AND NITRITE AND NITRATES OF POTASSIUM AND CALCIUM.

SUMMARY.

DESCRIPTION.

Nitrate of soda, cubic nitrate, or Chilean saltpeter when pure is a white salt having the chemical formula $NaNO_3$. There are two commercial grades, one contains 91 to 95 per cent of sodium nitrate for fertilizer purposes and the other contains 96 to 97 per cent sodium nitrate for the manufacture of nitric acid and other chemicals. In normal times the larger part of the consumption of nitrate of soda is for fertilizer purposes, but during the war the larger part was for explosive purposes.

Nitrite of soda, or sodium nitrite, differs from nitrate of soda in that it contains one less atom of oxygen per molecule; it has the chemical formula $NaNO_2$. The commercial product contains between 96 and 98 per cent of sodium nitrite. It is used chiefly for the manufacture of azo dyes and in the dyeing of textiles.

Nitrate of potash, or saltpeter, is very similar to nitrate of soda in its chemical properties. There are two commercial grades—a crude product used principally for fertilizer purposes and a refined grade used for explosives and for chemical purposes.

Calcium nitrate, or nitrate of lime, is a nitrate fertilizer material. It is used for fertilizer purposes only and competes directly with nitrate of soda.

DOMESTIC PRODUCTION.

Nitrate of soda, nitrate of potash, and calcium nitrate are not produced in the United States, with the exception of a small quantity of nitrate produced by the American Nitrogen Products Co., Seattle, Wash. Practically the entire consumption of these materials is imported into the United States.

Sodium nitrite is produced from nitrate of soda by means of lead by the E. I. DuPont de Nemours Co., from atmospheric nitrogen by the American Nitrogen Products Co., and by the oxidation of ammonia by the Semet-Solvay Co., Syracuse, N. Y. In 1917 the Geological Survey reported a production of 861 short tons of nitrite of soda. This quantity was not sufficient to meet domestic consumption as there was imported during the same year over 1,800 short tons. There is a large increased demand for nitrite of soda by the new dye industry.

FOREIGN PRODUCTION.

Nitrate of soda.—The only deposits of natural nitrate of soda which are of commercial importance are located in Chile. The production in Chile since 1910 has been approximately 3,000,000 short tons

annually with the exception of 1915, when the output declined about 2,000,000 tons, due to the disorganization of the industry caused by the presence of a German fleet in South American waters in the latter part of 1914.

The Chilean Government levies an export duty on nitrate of soda amounting to $11.19 per ton. This duty raises more than $32,000,000 per year, which is over 50 per cent of the total revenue collected by the Chilean treasury.

Consumption of Chilean nitrate by countries in 1918.[1]

Country.	Per cent of total.	Country.	Per cent of total.
Germany	32.6	Italy	2.0
United States	23.0	Egypt	1.0
France	12.8	Spain	.5
Belgium	12.5	Austria-Hungary	.3
Holland	6.4	Denmark	.4
United Kingdom	5.0	Others	3.5

[1] Calculated from statistics taken from Production et Consommation des Engrais Chimiques dans le Monde, Institut International d'Agriculture, Rome, Italy.

During the war virtually all the selling of Chilean nitrate was to the British and United States Governments, and nearly two-thirds of the total was shipped to the United States during 1918. With the war over Chilean nitrate will have to face competition from synthetic nitrates and nitric acid.

Nitrate of potash.—British India and Germany are the two largest producers of nitrate of potash. The Indian product is from natural deposits, while the German product is made from Chilean saltpeter by treatment with potash salts, which Germany controlled. Prior to the war (1913) Germany was supplying an increasing portion of the imports of nitrate of potash. The DuPont Company has developed the separation of nitrate of potash from Chilean saltpeter and the United States is receiving considerable nitrate of potash from this source.

Calcium nitrate.—This article is produced principally by the Norwegian Nitrate Works Co.; the annual production is about 90,000 tons.

IMPORTS.

Until 1916 our imports of nitrate of soda were between 500,000 and 600,000 long tons per year. During 1916 and 1917 over 1,000,000 tons were imported each year, and in 1918 over 1,800,000 tons. Practically all of the import was from Chile and the small imports from Canada and Germany were probably reexports.

The imports of crude nitrate of potash prior to 1914 fluctuated between 3,500 and 8,500 short tons annually. On an average about 5,500 tons were imported per annum. The imports declined to about 300 tons in 1915, and then increased until in 1917 about 5,000 tons were imported. Prior to 1913 over 90 per cent of the imports were from British India. In 1913 Germany supplied about 45 per cent of the imports.

The imports of nitrite of soda have increased from about 850 short tons in 1914 to about 1,800 tons in 1917. This increase is undoubtedly due to the development of our new dye industry.

Import statistics of calcium nitrate are combined with calcium acetate and chloride. The Federal Trade Commission reported in 1916 that between 3,000 and 4,000 tons of calcium nitrate were imported annually, almost entirely from Norway. Practically all was imported on the Pacific coast for use of the citrus fruit growers.

PRICES.

The spot price prevailing during 1918 on nitrate of soda was double the normal prewar price. The selling of virtually all of the nitrate in this country during 1918 was to the United States Government. The average price of nitrate of soda in London during 1916 was $3.86 per 100 pounds as against about $2.20 before the war. Average prices in various ports shown on page 86 show the difference existing in the price of nitrate in the world's markets. The price at New York is usually higher than in Europe. This is due to the fact that charter rates to the United States are always higher, owing to the uncertainty of a return cargo. With stocks of nitrate in Chile abnormally large at the beginning of 1915 and the largest consuming country in Europe, Germany, eliminated as a buyer, the industry was in a state of depression and values were at low marks. In domestic markets nitrate was quoted at $1.85 per 100 pounds. The influence of higher ocean freight rates soon was felt and prices started upward and continued through the year and by the first of the year 1916 had reached $3.25 per 100 pounds.

The closing of the Panama Canal was quite disturbing in the latter half of 1915 as it increased freight rates and thus put up the price as delivered at domestic points. Besides the sharp rise in price the feature of the year was the record shipments to this country. The big buying did not come from the fertilizer trade but the manufacturers of military explosives.

The price of nitrate in Chile showed no marked increase until 1917 and even then the increase was not in proportion to the increase in foreign countries.

Nitrite of soda was quoted in 1915 at about 18 cents per pound, the price during 1918 was about 36 cents per pound.

Saltpeter or nitrate of potash, crude, prior to October, 1914, sold at about 5 cents per pound. At this time the price began to increase until, by January, 1916, a maximum was reached which was seven to eight times the normal prewar price, due to the scarcity and high prices of muriate of potash and nitrate of soda. Since January, 1916, crude saltpeter has not been quoted on the open market and the refined grade has sold at about 30 cents per pound. In 1917, 1918, 1919, the price has dropped gradually to 13¾ cents in 1920. The demand is heavy but does not seem to affect the price.

TARIFF HISTORY.

Nitrate of soda or cubic nitrate has always been free of duty.

Nitrate of potash or saltpeter, under the act of 1883, was dutiable; the crude product at 1 cent per pound and the refined at 1½ cents per pound. The act of 1890 placed crude nitrate of potash on the free list where it has been since that time. The duty on the refined article was reduced to 1 cent per pound by the act of 1890 and to

½ cent per pound by the act of 1894; this duty was in force until the passage of the act of 1913, which levied a duty of $7 per ton, which is a reduction of $3 per ton.

Nitrite of soda was first mentioned by name in the act of 1897 as dutiable at 2½ cents per pound. This duty was reduced by the act of 1909 to 2 cents per pound and there was a further reduction by the act of 1913 to ½ cent per pound.

Calcium nitrate or nitrate of lime was first mentioned by name in the act of 1913, paragraph 440 of the free list.

Nitrite of soda—Summary table.

Year.	Domestic production.	Imports for consumption.	Ratio to production (imports).
	Pounds.	*Pounds.*	*Per cent.*
1910		1,132,778	
1911		477,707	
1912		974,667	
1913		1,269,544	
1914		1,844,379	
1915		1,696,567	
1916		2,593,330	
1917	1,722,000	3,675,179	213
1918	3,402,000	2,755,033	81
1919	1,352,000	2,550,689	188

Year.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity (pound).	Equivalent ad valorem rate.
				Per cent.
1910 [1]	$52,234	$22,655	$0.046	43.37
1911	21,205	9,554	.044	45.06
1912	47,399	19,493	.048	41.13
1913	57,595	25,390	.045	44.09
1914 [2]	76,813	16,938	.041	12.19
1915	74,267	8,482	.044	11.42
1916	170,160	12,966	.066	7.62
1917	261,655	18,375	.071	7.02
1918	248,294	13,775	.082	6.08
1919	246,792	12,753	.097	5.17

[1] From Aug. 6, 1909, until June 30, 1910. [2] From Oct. 4, 1913, until June 30, 1914.

General Information.

The articles covered by this catalogue are mentioned in the act of 1913, as follows.

Par. 605. Soda, nitrate of, or cubic nitrate. (Free list.)
Par. 440. * * * calcium nitrate. (Free list.)
Par. 67. Soda, and nitrite of, ½ cent per pound.
Par. 64. Potash, nitrate of, or saltpeter, refined, $7 per ton.
Par. 580. Potash, nitrate of, or saltpeter, crude. (Free list.)

NITRATE OF SODA.

Description and uses.—Nitrate of soda, sodium nitrate, cubic nitrate, niter, or Chilean saltpeter when chemically pure, is a white salt readily soluble in water. It has the chemical formula $NaNO_3$. The commercial nitrate which is grayish white in color is of two grades: 1. For fertilizer purposes which contains from 91 to 95 per

cent of sodium nitrate corresponding to about 15 per cent of nitrogen. It also contains a small per cent of salt, moisture, and small amounts of other impurities. 2. A refined niter with a standard content of 96 to 97 per cent sodium nitrate and less than 2 per cent of salt. This grade is used mainly for the manufacture of nitric acid and for other chemical purposes.

The nitrogen contained in nitrate of soda is generally spoken of as nitrate nitrogen which is believed to be the form most readily assimilated by plants. Nitrate of soda is especially effective as a top dressing for certain kinds of crops, such as sugar beets, cotton, and citrus fruits. The principal disadvantage of nitrate of soda for fertilizer purposes is that it is readily leached from the soil if a heavy rain occurs before the nitrate has been assimilated by the vegetation. The nitrate also has the tendency to take up moisture, causing it to become lumpy and difficult to spread or mix properly.

In normal times the larger part of the nitrate of soda consumed in the United States is for fertilizer purposes. In 1913 the Federal Trade Commission [1] reported that the consumption of nitrate of soda was 40 to 55 per cent for fertilizers, 35 to 41 per cent for explosives, and 10 to 20 per cent for chemical, glass, and dye works. These percentages were based on estimates submitted by informants in close touch with the nitrate industry. It also estimated that the consumption of nitrate of soda for fertilizer purposes during the calendar year 1913 was 250,000 tons distributed as follows:

	Tons.
In mixed fertilizer	150,000
To farmers in unmixed form	90,000
Making sulphuric acid for acid phosphate, base goods and sulphate of ammonia	20,000

This quantity is about 40 per cent of the total (649,168 tons) consumed for that year.

The census of manufactures for 1914 shows the following consumption of nitrate of soda by industries: Explosives, 190,960 tons, valued at $8,979,877; fertilizers, 162,184 tons, valued at $7,511,809; chemical industry, 58,101 tons, valued at $2,696,172.

During the period of the present European war the consumption of nitrate of soda by industries reversed; by far the larger portion of the nitrate consumed in the United States is for the manufacture of explosives. In fact the quantity consumed by the fertilizer trade has been reduced considerably as a matter of military necessity.

Sources of nitrate of soda.—The only known deposits of natural nitrate of soda which are of commercial importance are those located in the rainless regions of northern Chile. Scattered small deposits of low-grade nitrate have been found in this country, especially in southern California. Similar deposits have been found in Egypt. In the regions of Peru and Bolivia adjacent to Chile deposits have been discovered recently which may prove to be of commercial value.

Calcium nitrate, made from synthetic nitric acid obtained by the fixation of atmospheric nitrogen has been able to compete with Chile saltpeter. (See calcium nitrate on following pages.) There are also other electrical processes (cyanamid for example) which afford an economical means of obtaining other nitrogenous fertilizers.

[1] Report on the Fertilizer Industry, Federal Trade Commission, Aug. 19, 1916.

Production of nitrate in Chile.—The nitrate region of Chile embraces a zone about 500 miles in length, from north to south, located on the eastern slope of the first range of mountains. The beds are found at distances from the coast of 20 to 100 miles, and at altitudes of from 4,000 to 12,000 feet above sea level.

The nitrate-bearing earth or "caliche," which is found a few feet below the surface, has a thickness varying from a few inches up to 12 feet, the average thickness being approximately 2 feet. The saltpeter or sodium nitrate content of the caliche varies considerably, the medium qualities containing from 30 to 40 per cent and the best grades from 40 to 50 per cent. For commercial purposes the deposits averaging above 15 per cent are now worked. The caliche is blasted out in large lumps and separated from the overburden material. It is then loaded into carts or small cars and hauled to the refining plant; here it is broken into fine lumps by crushers. The nitrate is then leached from this material by means of boiling hot water. About 12 gallons of water are required for every 100 pounds of finished nitrate. The extraction usually takes from 20 to 24 hours. The solution is then concentrated, clarified, and run into large crystallizing tanks. The crystals when sufficiently dry are thrown on the stock pile where the winds and sun complete the drying process. The nitrate is then placed in bags containing about 220 pounds and loaded onto cars for shipment to the ports. Here it is put on board ship by lighters as there are no harbors along the coast of Chile. The efficiency of the extraction of nitrate in the Chilean factories is surprisingly low. The usual recovery amounts to about 70 per cent of the nitrate which is contained in the caliche. The greatest loss of nitrate appears to be in the slimes. These slimes are now (1918) being handled more economically and the percentage of recovery may be expected to be greater than in the past.

S. Nauchoff, in an article published in Metallurgical and Chemical Engineering, 1917, page 527, gives the following distribution of the price of sodium nitrate, showing the cost of production, at a normal price of about $44 per ton f. o. b. a port in the North Sea:

	Per ton.
Cost of production	$13.10
Export duty	11.92
Transportation	4.17
Commercial expense and profit	14.88
Total	44.07

During November, 1917, saltpeter was quoted in Liverpool at about $97 per ton.

	Per ton.	
	Low.	High.
Cost of production	$17.00	$19.45
Export	12.18	12.18
Freight	36.50	36.50
Commercial expense and profit	31.60	26.80
Total	97.28	97.33

Taking the figure of normal price the cost of production plus the export duty gives a cost of $1.25 per 100 pounds which includes probably all expense alongside the vessel with the exception of commissions to agents. The figures with prices in November, 1917, give a low cost alongside vessel of $1.46 and a high figure of $1.58 per 100 pounds.

Since 1880 a tax amounting to $11.19 per net ton (3.38 pesos [1] gold per 100 kilo) has been levied on all exports of nitrate of soda. This duty, owing to method of collection in gold currency brought about by the war, amounts to about $16.75 per ton. In normal times this duty yields about $32,000,000, or about one-half of the total revenue of the Chilean Government. In addition the Chilean Government derives an income from the sale of its lands. At certain periods auctions are held by a special legislative act, the quantity and quality of the nitrate contained in the lands to be sold having been appraised by the Government and the minimum is fixed. The Government also contributes liberally to a propaganda fund to encourage consumption and has an agent stationed in Europe to keep it informed of the market conditions and the result of the propaganda in these markets.

In 1913 there were about 77 nitrate companies in Chile, which together operated 127 oficinas, with several idle and others under construction. Up to recent date the only American company engaged in the mining of caliche was the Du Pont Nitrate Co., a subsidiary of the E. I. Du Pont de Nemours Powder Co., Wilmington, Del. The Grace Nitrate Co., incorporated in October, 1916, purchased various properties, representing a transaction of some $3,000,000. Its oficina is a thoroughly up-to-date property and is the largest American-owned nitrate plant in Chile. Its output is roughly 4,000 tons of nitrate per month, which will be increased to 6,000. The capitalization of companies owning nitrate oficinas and railroads was estimated in 1909 by a prominent Chilean Government official at approximately $134,000,000. This same authority values the properties at less than $30,000,000. Most of the companies have been formed since 1900 and are as a rule overcapitalized.

Much of the nitrate produced in Chile is sold through commission houses to exporters. These exporters purchase their nitrate in the Valparaiso market, export it from the several ports of Chile and sell it in the various markets of the world. This export business is handled by about 25 firms. The four exporting the largest quantities are Antony Gibbs & Co., of Liverpool; Folsch & Co. and Weber & Co., of Hamburg; and W. R. Grace & Co., of New York. As a rule the nitrate is shipped in chartered vessels and the charter rate is an important item in the cost of placing the nitrate in the world's markets. This charter rate is higher to the United States on account of the uncertainty of a return cargo and accounts for higher prevailing prices in the United States than in European countries.

Effect of the war on the Chilean industry.—With the outbreak of the European war the shipments of Chilean nitrate practically ceased due principally to the presence in South American waters of a German fleet under the command of Admiral Von Spee. The presence of this fleet off the coast of South America was not an accident but one of

[1] Peso of 18 pence.

Germany's predetermined war plans. This menace to the shipment of Chilean nitrate of soda was removed as soon as Great Britain could get a large naval force to South American waters. Since nitrate of soda represents some three-fourths of the total exports of Chile and the Government derives over 50 per cent of its revenue from the export duty on nitrate, the temporary cutting off of the foreign market for this product represented a veritable calamity for Chile. The revenue derived from saltpeter decreased from $32,446,303 in 1913 to $23,369,471 in 1914, and it must be remembered that war was not declared until August of 1914.

The production decreased from a normal output of over 250,000 tons per month to a minimum in February, 1915, of 89,904 tons. The oficinas in operation decreased from 134 in July, 1914, to a minimum of 36 in March, 1915. Beginning with March, 1915, the production gradually increased until October, when the monthly production approximated the normal prewar output. At this time the number of oficinas in operation, however, was somewhat less than before the outbreak of the war, probably due to the cessation of operations of the German controlled companies. Aside from the sinking of the German fleet by the British navy the industry was stimulated by the Chilean Government, who encouraged the producers to continue operations by advancing 3 pesos for each quintal of nitrate mined and 4 pesos for each quintal ready for shipment.

The decline in exports of Chilean nitrate in the later part of 1914 from the normal prewar exports is shown by the following table:

[Tons of 2,000 pounds.]

	January to July.	August to September.
1913	1,545,410	1,472,716
1914	1,548,315	487,162
1915	1,152,552	.....

Although nitrate prices in countries foreign to Chile have risen markedly owing to war conditions, the price in Chile, owing to surplus stocks awaiting shipment, has not responded to the same degree as shown by the table of prices on page 86. At the present time (1918) virtually all of the selling of Chilean nitrate is to the British and United States Governments under a well-defined system; and the price quotation for some months past has been about $2.67 per 100 pounds in Chile. The United States is taking about two-thirds of the output of the Chilean mines.

Chilean nitrate statistics (short tons).

Year.	Chile.				
	Production.[1]		Exports of nitrate of soda.[2]	Revenue from export duty.[2]	Per cent of total revenue of Chile.[3]
	As nitrate of soda.	Equivalent of nitrogen on basis of 15.65 per cent.			
1913	3,055,808	478,234	3,015,479	$32,896,947	48
1914	2,715,047	424,905	2,034,374	23,751,756	52
1915	1,935,143	302,850	2,227,599	24,564,128	59
1916	3,210,008	502,366	3,280,660	36,599,903	59
1917	3,319,918	519,567	3,055,180	38,892,824	50
1918	3,170,106	496,122	3,289,325	40,333,936	44
1919[3]	556,817	87,142	167,328	.....	.....

[1] For 1913–1916, inclusive, from Association Salitrera de Propaganda; 1917–1919, from publications of International Institute of Agriculture, Rome, Italy.
[2] From Caliche, Organo del Instituto Cientifico E Industrial del salitre, Santiago, Chile, August, 1919.
[3] First three months.

Tariff consideration.—Tariff questions on nitrate of soda involve the recent developments of synthetic nitric acid and ammonia in this country. Until the entrance of the United States into the war entire dependence was placed on Chile for supplies of nitrate of soda needed for military explosives, chemicals, and fertilizers. The entry of the United States into the war radically changed the situation. The demands for explosives were enormously increased, and the alarming success of the German submarines during 1917 made dependence on Chile for nitrates increasingly dangerous. The possibility had to be faced that the German submarines would secure virtual command of the sea.

It was, therefore, sound public policy to take steps to insure an adequate supply of nitrates from sources beyond the reach of the submarine. The nitrate program of the War Department was enormously increased. On October 15, 1917, the erection of nitrate plant No. 1 was begun near Sheffield, Ala. This plant was planned to have a capacity of about 10,000 tons of ammonia to be made by the direct combination of nitrogen and hydrogen in accordance with plans prepared by the General Chemical Co. This process had not been previously operated on a large manufacturing scale and the War Department decided not to place entire reliance upon it. Certainty of production at an early date became the paramount consideration, and comparative cost and probable competitive strength after the war were of minor importance.

The cyanamid process was in successful large-scale operation at Niagara Falls, Canada, and the technical knowledge of the staff of this plant was available to the Government of the United States. A cyanamid plant could consequently be erected with assurance that when completed it would function properly without long delays to correct mistakes in design almost inevitable when the design is based solely on small-scale experiments.

Although no large-scale plant for the conversion of ammonia into nitric acid was in operation in the United States, much experimental work on the process had been carried out by the American Cyanamid Co., and by the Bureau of Mines in cooperation with the Semet-Solvay Co. These experiments had been sufficiently successful to justify reliance on this method in connection with the Haber and cyanamid processes in preference to the arc process, which was excluded on account of its enormous power requirements. Accordingly nitrate plant No. 2 was started near the Muscle Shoals on the Tennessee River near Sheffield, Ala. It was designed to produce 220,000 tons of calcium cyanamid, equivalent to 50,000 tons of ammonia annually. It is expected ultimately to use water power from Muscle Shoals, but since at least three years will be required to build the dams and power houses a steam-power plant was erected to furnish the power needed at once.

Before the construction of plant No. 2 had proceeded very far, the program was again increased and orders given for the construction of plant No. 3 near Toledo and plant No. 4 near Cincinnati, which were similar to No. 2 in design.

At the date of the signing of the armistice, plants Nos. 1 and 2 were in operation in part, although all the units were not yet completed. Plants Nos. 3 and 4 had advanced only a little beyond the preliminary work of clearing the land and laying foundations. Further work on No. 3 and No. 4 was stopped, and these plants have been abandoned.

Plant No. 1, which was to produce synthetic ammonia, however, was not completely successful. Mistakes were made in the design, so that the completed plant did not operate in an entirely satisfactory way. This is not surprising since the designs were based on experiments on a much smaller size, and no one in America had any experience in the operation of a large size commercial plant. Ordinary business prudence, which requires that every detail of design should be perfected through construction, operation, and modification of a single large size unit before the construction of a large plant of many units, was deliberately neglected in this case on account of the urgent necessity for speed. Much of the construction is of good usable quality, including railroad connections, the village for workmen, power plant, repair shops, offices, factory buildings, and a large part of the special manufacturing equipment. Some of the special equipment for the process will have to be redesigned and rebuilt. The titles to the patents on the Haber process have been seized by the Alien Property Custodian, and, therefore, the need of avoiding infringement will no longer hamper the reconstruction of the plant. There can be little doubt that it can be put in good working condition by the expenditure of a small fraction of the original cost. The cyanamid plant (Nitrate Plant No. 2) is of good design and in good working order, the design having been prepared by engineers experienced in the operation of a successful large plant.

The final disposition of these plants which are owned by the Government has not been decided at the present time (January, 1921).

There are three possible methods of disposition: First, Government ownership and operation of the plants directly or indirectly through a corporation controlled by the Government; second, the sale of the plants to private firms with the idea that they would operate them for the production of fertilizer materials if a purchaser can be found; third, the Government to retain the ownership and not operate the plants, holding them in reserve for military emergency.

SODIUM NITRITE.

Description and uses.—Sodium nitrite is a chemical compound of the formula ($NaNO_2$). It forms small crystals which possess a faint yellow color; the pure dry salt is colorless. The salt dissolves readily in water. The commercial product contains between 96 and 98 per cent of sodium nitrite.

Sodium nitrite is used chiefly in the manufacture of azo dyes and in the dyeing of textiles, where it is used to develop the color on the fiber. It also has minor laboratory and pharmaceutical uses.

Occurrence and preparation.—Sodium nitrite occurs native in small amounts in Chile saltpeter. It has been usually prepared, however, by the reduction of sodium nitrate (Chile saltpeter). The reducing agents are usually lead, iron filings, or graphite.

On a large scale sodium nitrite is made by reducing sodium nitrate by means of lead. The lead used should be as free as possible from zinc and antimony. The nitrate of soda is first melted in a cast-iron vessel; the required amount of lead is then added, keeping the liquid in constant agitation. The product from this fusion contains over 90 per cent sodium nitrite and some caustic soda and unreduced nitrate of soda. This mass is extracted with water, the alkaline liquid is neutralized with nitric acid, and allowed to settle. The clear liquid is now evaporated and run into lead-lined wooden tanks to crystallize. The mother liquors from the first batch of crystals can be evaporated several successive times with a yield of crystals each time. The crystals obtained, however, decrease in purity with the increase in number of evaporations. If an especially pure product is desired the salt is recrystallized.

Sodium nitrite is also produced from atmospheric nitrogen and by the oxidation of ammonia, which may be produced from by-product coke ovens or synthetically from atmospheric nitrogen. In the oxidation of nitrogen by the arc process equal volumes of nitrous and nitric oxide can be produced under certain conditions. This mixture when absorbed in a solution of soda ash forms sodium nitrite. The same proportion of nitrous and nitric oxides can be obtained in the ammonia oxidation process and can be absorbed to form sodium nitrite. The arc process method is used in Norway, and by the American Nitrogen Products Co., Seattle, Wash., while the ammonia oxidation method is being used by the Solvay Process Co., at Syracuse, N. Y.

Imports.—The imports of sodium nitrite have increased from 1,696,567 pounds in 1915 to 3,675,179 pounds in 1917. This increase can be accounted for by the establishment of a dye industry in the United States.

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POTASSIUM NITRATE.

Description and uses.—Potassium nitrate or saltpeter is a chemical compound containing potassium, nitrogen, and oxygen. It has the chemical formula KNO_3. It is very similar to sodium nitrate in its chemical properties. When pure it is a white crystalline powder, or transparent colorless prisms. It is readily soluble in water and has a cooling saline taste. There are two grades of nitrate of potash, a crude product used principally for fertilizer purposes and a refined grade used for chemical purposes. The crude is admitted free of duty while the refined is dutiable at $7 per ton.

The chief use of nitrate of potash is in the manufacture of explosives and fertilizers. The Census of Manufactures for 1914 shows that the explosives industry consumed about 2,700 short tons of nitrate of potash, which was a decrease from the consumption in 1909 of about 3,500 short tons. The same source shows that in 1914 that the fertilizer industry consumed 507 short tons of nitrate of potash valued at $28,287. Potassium nitrate is also used in the manufacture of matches, in pyrotechnics, in assaying, in metallurgical operations, for analytical purposes, and for curing meat. It has a minor use for pharmaceutical purposes.

Occurrence and preparation.—Potassium nitrate or saltpeter is obtained, chiefly, from natural deposits in British India and from nitrate of soda by treatment with potassium chloride.

In many tropical countries, especially in India, Persia, and Egypt native deposits of potassium nitrate are found impregnating the earth in the neighborhood of large cities. The most important deposits are in the district of Tirhut, Bengal. The deposits are constantly forming, a white crust appears on the surface and is scraped up, lixiviated with water, and the clear solution evaporated to obtain the nitrate of potash.

In addition to these Indian earths the Chilean nitrate-bearing earths or "caliche" contain nitrate of potash varying from 1 to as high as 18 per cent in some deposits. The E. I. Du Pont Co. has developed a method for separating the nitrate of potash from the nitrate of soda in working the Chilean caliche. This process is now supplying considerable nitrate of potash to this country and should continue to develop, as it is worked in conjunction with the production of nitrate of soda.

There is also some potassium nitrate-bearing earths in Mexico and Central America. These deposits are very similar to those in India. Offerings from this source have been made to the American manufacturers of fertilizers but the price has been too high to compete with Indian nitrate from British India which is now being secured by a cooperative agreement with the British Government.

The most important commercial source of nitrate of potash is from nitrate of soda by treatment with potassium chloride. A hot solution of potassium chloride is treated with the required amount of nitrate of soda, the two materials combining to form nitrate of potash and common salt. On evaporation of the solution, the salt being the more insoluble precipitates out and is removed from the solution. When the solution has reached a certain density, the clear liquor is drawn off into crystallizing tanks. Here it is allowed to cool while

being agitated and the nitrate of potash crystallizes as a fine meal known as "crystal meal."

Prior to the fiscal year 1913 over 90 per cent of our imports of crude nitrate of potash came from British India. In 1913 we received about 55 per cent from India and about 44 per cent from Germany. This shows that Germany was fast increasing her hold on this article. In 1914 the imports from Germany were very small and since have been cut off entirely. The total imports of crude nitrate of potash during 1914 and 1915 were far below normal prewar imports. In 1917 the imports became normal again.

CALCIUM NITRATE OR NITRATE OF LIME.

Calcium nitrate or nitrate of lime is an inorganic nitrogen compound which is used to some extent as a fertilizer material. It is a white salt obtained by combining nitric acid, usually produced by synthetic processes, with lime. It contains 4 molecules of water and has the chemical formula $Ca(NO_3)_2 4H_2O$. It has a nitrogen content of 13 per cent as compared with 15.5 per cent of nitrogen in Chilean nitrate of soda. On soils where lime is needed it is more effective than nitrate of soda. The principal defect in nitrate of lime is that it absorbs moisture very readily and deteriorates in quality on exposure to air. It is necessary, therefore, to ship it in casks instead of bags. It is also disagreeable to handle. For these reasons nitrate of lime is not generally finding favor as a fertilizer material.

Nitrate of lime is manufactured principally by the Norwegian Nitrate Works Co., the annual production being about 90,000 tons. Considerable quantities are also made in Germany. A factory using the Pauling arc process was built in 1912 at Nitrolee, S. C., for the manufacture of 8 tons of nitrate of lime daily. This plant operated only a year or two, as there was a more profitable market for the electrical power than for the calcium nitrate.

The Federal Trade Commission reports in 1916 that between 3,000 and 4,000 tons of nitrate of lime are imported annually into the United States, almost entirely from Norway, for fertilizer and other purposes. Of this quantity all but about 400 tons is imported on the Pacific coast, where it is used largely by the citrus fruit growers of California. Hawaii also takes considerable quantities for fruit orchards and sugar plantations. The distribution in the United States is through exclusive agents.

The official import statistics combine nitrate of lime with acetate and chloride of lime, so separate figures are not available.

Nitrite of soda—Production in United States.

[From U. S. Geological Survey.]

Year.	Short tons.	Value.
1917	861	$480,145
1918	1,701	609,779
1919[a]	676	151,621

[a] Production of American Nitrogen Products Co., Seattle, Wash. is not included in this total.

Nitrate of soda or cubic nitrate—Imports by countries (fiscal years).

Imported from—	1909		1910		1911	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Germany	6,032	$266,369	10	$260	85	$3,653
Canada	18,338	1,020,960	11,867	626,160	17,979	851,419
Chile	329,124	11,296,083	538,119	16,225,296	528,435	16,244,812
Total	353,494	12,583,417	550,495	16,874,602	546,525	17,101,140

Imported from—	1912		1913		1914	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Germany	84	$3,909	45	$2,408	20	$1,032
Canada	6,095	304,773	15,316	774,006	2,810	140,475
Chile	475,560	15,123,210	573,773	19,942,419	561,209	17,808,763
Total	481,739	15,431,892	589,136	20,718,968	564,049	17,950,786

Imported from—	1915		1916		1917	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Canada	2	95	4,717	$217,863	.....	.....
Chile	577,120	$16,355,595	1,067,005	31,911,384	1,261,659	$44,231,240
Total	577,122	16,355,701	1,071,728	32,129,397	1,261,659	44,231,240

Nitrate of potash, crude—Imports by countries (fiscal years).

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	510	$29	450,556	$7,741	132,710	$2,195
England	66,231	2,007	.....	.....	.....	.....
Canada	1,360	40	.....	.....	.....	.....
British India	17,400,555	510,357	11,306,332	339,690	9,144,837	280,354
Total	17,470,656	512,473	11,757,254	347,440	9,277,547	282,549

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	804,323	$13,593	4,964,700	$80,593	112,717	$2,167
Canada	.....	.....	23,178	1,014	.....	.....
British India	6,171,431	213,258	6,166,352	207,358	3,433,863	113,177
Russia	.....	.....	56,988	1,485	.....	.....
Total	6,975,754	226,851	11,213,926	290,492	3,546,580	115,344

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
England	.....	.....	4,282,960	$577,055	5,102,643	$736,594
Canada	.....	.....	120,415	27,695	.....	.....
British India	670,930	$22,083	1,106,770	152,705	456,000	82,300
Japan	.....	.....	22,400	4,363	10,192	1,747
Total	677,785	22,483	5,532,545	761,818	10,171,654	904,506

Soda, nitrate of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Tons.				*Per cent.*
1908	Free	329,604	$12,547,511		38.07	
1909	do	353,557	12,583,416		35.59	
1910	do	548,269	16,874,602		30.77	
1911	do	546,394	17,101,155		31.30	
1912	do	481,786	15,427,904		32.02	
1913	do	586,314	20,713,375		35.33	
1914	do	554,047	17,926,165		32.35	
1915	do	575,371	16,240,510		28.22	
1916	do	1,072,833	32,129,926		29.94	
1917	do	1,261,933	44,428,196		35.20	
1918	do	1,608,569	70,077,574		43.57	

Potash, nitrate of, or saltpeter—Imports for consumption—Revenue.

CRUDE.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	16,748,117	$517,334		$0.030	
1909	do	17,470,648	512,473		.029	
1910	do	11,848,195	349,199		.027	
1911	do	9,288,557	282,835		.030	
1912	do	6,172,441	213,258		.035	
1913	do	10,989,382	288,995		.026	
1914	do	3,547,252	115,470		.033	
1915	do	677,785	22,483		.033	
1916	do	5,412,130	734,123		.135	
1917	do	10,171,654	904,506		.088	
1918	do	8,815,327	956,853		.108	

REFINED.

1908	½ cent per pound	326,759	$17,487	$1,633	$0.054	9.34
1909	do	415,281	14,421	2,076	.035	14.40
1910	do	2,610,941	115,457	13,054	.044	11.30
1911	do	851,681	38,384	4,258	.045	11.09
1912	do	442,862	23,896	2,214	.054	9.27
1913	do	393,605	22,142	1,968	.056	8.89
1914	do	77,000	4,306	385	.056	8.94
1914	$7 per ton	287,840	15,867	899	.055	5.67
1915	do	76,160	4,222	238	.055	5.64
1916	do	4,480	749	14	.167	1.87
1917	do	645,120	35,143	2,016	.054	5.74
1918	do	96,320	16,193	301	.168	1.86

Soda, nitrite of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	2½ cents per pound	199,857	$10,015	$4,996	$0.050	49.91
1909	do	152,393	7,258	3,809	.048	52.49
1910	do	24	4		.167	
1910	2 cents per pound	1,132,754	52,233	22,655	.046	43.37
1911	do	477,707	21,205	9,554	.044	45.06
1912	do	974,667	47,399	19,493	.049	41.13
1913	do	1,269,544	57,595	25,390	.045	44.09
1914	do	153,143	7,447	3,062	.049	41.13
1914	½ cent per pound	1,691,236	69,366	8,456	.041	12.19
1915	do	1,696,567	74,267	8,482	.043	11.42
1916	do	2,593,330	170,160	12,966	.065	7.62
1917	do	3,675,179	261,655	18,375	.071	7.02
1918	do	2,755,033	248,294	13,775	.090	6.09

Nitrate of soda, prices (wholesale) per 100 pounds, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	January.	April.	July.	October.
1912	$2.20 –$2.22	$2.35 –	$2.45 –$2.47	$2.55 –
1913	2.55 –	2.60 –	2.47 –	2.35 –
1914	2.20 –	2.22 –	2.15 –	1.90 –
1915	1.90 –	2.22 –	2.35 –	2.55 –
1916	3.25 –	3.40 –	3.10 –	2.90 – 2.95
1917	3.25 –	3.75 –	– 4.15	4.97 – 5.00
1918	[1] 4.50 – 4.60	5.00 – 5.10	4.75 – 4.80	– 4.32
1919	4.42½–	4.07½–	3.00 –	2.87½– 2.90
1920	3.05 –	3.90 –	3.85 –	3.35 –

[1] Nominal.

Prices of nitrate in Chile alongside vessel.

	Per 100 pounds.		Per 100 pounds.
1910	$1.66–	1914	1.66–
1911	1.68–	1915	1.75–
1912	1.91–	1916	1.83–
1913	1.87–	1917	2.11– 2.63

Nitrate of soda, prices (wholesale) per 100 pounds, New York, futures.

[From Oil, Paint, and Drug Reporter.]

	January.	April.	July.	October.
1912	$2.20 –$2.22	$2.35	$2.45–$2.47	$2.57
1913	2.57	2.57	2.40	2.40
1914	2.22 – 2.27	2.22	2.12	$1.80 – 1.90
1915	1.90	2.20	2.35	2.55
1916	3.20	3.10	3.07	2.90 – 2.95
1917	3.25	3.75	4.05– 4.25	4.60 – 4.97½
1918	4.45 – 4.60	5.25 – 5.50	[1] 4.10–	[1] 4.40 –
1919	4.42½–	4.07½–	2.90– 3.00	2.87½– 2.97½
1920	[2]	[2]	4.10– 4.25	3.15 – 3.65

[1] Government fixed price. [2] Not quoted.

Nitrate of soda, average yearly price per 100 pounds; quotations in Liverpool of 95 per cent grade of nitrate of soda.

[From American Fertilizer, Mar. 3, 1917.]

1905	$2.34	1911	$2.15
1906	2.48	1912	2.41
1907	2.44	1913	2.41
1908	2.22	1914	2.22
1909	2.12	1915	2.75
1910	2.04	1916	3.86

Nitrate of soda, prices, taken from the Federal Trade Commission's report on the fertilizer industry. The prices are indicative of the difference between the different markets.

Years by quarters.	Chile, alongside vessel.	Dunkirk, France.	Antwerp, Belgium.	Hamburg, Germany.	Liverpool, England.	New York, United States.
1912	$1.77	$2.10	$2.10	$2.10	$2.18	$2.20
1912	1.80	2.30	2.32	2.31	2.40	2.40
1912	1.96	2.30	2.29	2.25	2.39	2.46
1912	2.06	2.38	2.43	2.38	2.52	2.56
1913	1.96	2.44	2.43	2.46	2.53	2.58
1913	1.88	2.42	2.48	2.47	2.58	2.61
1913	1.83	2.13	2.15	2.14	2.28	2.33
1913	1.88	2.23	2.21	2.18	2.32	2.26
1914	1.87	2.20	2.20	2.18	2.26	2.22
1914	1.80	2.09	2.10	2.07	2.23	2.24

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...ound.]

Value (imports for consumption).	Amount of duty.	Value per unit of quantity (pound).	Equivalent ad valorem rate.
$1,045	$261.00	$0.017	25.00
750	188.00	.017	25.00
(2)	(2)	(2)	(2)
14	3.50	.467	25.00
23,967	[3] 3,412.00	[3].018	[3] 13.67
7,765	1,213.00	.016	15.62
79	2.67	.074	3.38
521	3.90	.333	.75
69	.28	.616	.41

...merce and Navigation.

...TION.

...sodium phosphates known ...ans. The most important ...erce is disodium phosphate ...wn as neutral phosphate, ...e phosphate meant when ... is used. This phosphate ...al uses, as it is more stable ...luble in water and crystal- ...ms containing twelve mole- ...e to air gradually lose their ...phate is crystallized from a ...ystals containing only seven ...do not lose their water on ...a phosphate melt at 30° C., ...ion at 100° C. On further ... into sodium pyrophosphate, ...0° C.

...aceutical purposes "contains ...han 44 per cent of anhydrous ...sphate) corresponding to not ... salt."

...o textile ...ecially ... is also ... g. It ...ained

Nitrate of soda, prices (wholesale) per 100 pounds, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	January.	April.	July.	October.
1912	$2.20 –$2.22	$2.35 –	$2.45 –$2.47	$2.55 –
1913	2.55 –	2.60 –	2.47 –	2.35 –
1914	2.20 –	2.22 –	2.15 –	1.90 –
1915	1.90 –	2.22 –	2.35 –	2.55 –
1916	3.25 –	3.40 –	3.10 –	2.90 – 2.95
1917	3.25 –	3.75 –	– 4.15	4.97 – 5.00
1918	[1] 4.50 – 4.60	5.00 – 5.10	4.75 – 4.80	– 4.32
1919	4.42½–	4.07½–	3.00 –	2.87½– 2.90
1920	3.05 –	3.90 –	3.85 –	3.35 –

[1] Nominal.

Prices of nitrate in Chile alongside vessel.

	Per 100 pounds.		Per 100 pounds.
1910	$1.66–	1914	1.66–
1911	1.68–	1915	1.75–
1912	1.91–	1916	1.83–
1913	1.87–	1917	2.11– 2.63

Nitrate of soda, prices (wholesale) per 100 pounds, New York, futures.

[From Oil, Paint, and Drug Reporter.]

	January.	April.	July.	October.
1912	$2.20 –$2.22	$2.35	$2.45–$2.47	$2.57
1913	2.57	2.57	2.40	2.40
1914	2.22 – 2.27	2.22	2.12	$1.80 – 1.90
1915	1.90	2.20	2.35	2.55
1916	3.20	3.10	3.07	2.90 – 2.95
1917	3.25	3.75	4.05– 4.25	4.60 – 4.97½
1918	4.45 – 4.60	5.25 – 5.50	[1] 4.10–	[1] 4.40 –
1919	4.42½–	4.07½–	2.90– 3.00	2.87½– 2.97½
1920	[2]	[2]	4.10– 4.25	3.15 – 3.65

[1] Government fixed price. [2] Not quoted.

Nitrate of soda, average yearly price per 100 pounds; quotations in Liverpool of 95 per cent grade of nitrate of soda.

[From American Fertilizer, Mar. 3, 1917.]

1905	$2.34	1911	$2.15
1906	2.48	1912	2.41
1907	2.44	1913	2.41
1908	2.22	1914	2.22
1909	2.12	1915	2.75
1910	2.04	1916	3.86

Nitrate of soda, prices, taken from the Federal Trade Commission's report on the fertilizer industry. The prices are indicative of the difference between the different markets.

Years by quarters.	Chile, alongside vessel.	Dunkirk, France.	Antwerp, Belgium.	Hamburg, Germany.	Liverpool, England.	New York, United States.
1912	$1.77	$2.10	$2.10	$2.10	$2.18	$2.20
1912	1.80	2.30	2.32	2.31	2.40	2.40
1912	1.96	2.30	2.29	2.25	2.39	2.46
1912	2.06	2.38	2.43	2.38	2.52	2.56
1913	1.96	2.44	2.43	2.46	2.53	2.58
1913	1.88	2.42	2.48	2.47	2.58	2.61
1913	1.83	2.13	2.15	2.14	2.28	2.33
1913	1.88	2.23	2.21	2.18	2.32	2.26
1914	1.87	2.20	2.20	2.18	2.26	2.22
1914	1.80	2.09	2.10	2.07	2.23	2.24

Nitrite of soda, prices (wholesale) spot, New York, per pound.

[From Oil, Paint, and Drug Reporter.]

	1915	1916	1917	1918	1919	1920
TECHNICAL.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January		18–21	18–21	40–43	19–20	13–14
April	7½–7½	18–21	18–22	36–37	14–15	24–30
July	18–21	18–21	[1]32–38	32–33	11–12	15–15½
October	18–21	18–21	42–44	32–33	11–12	13–13½
UNITED STATES PHARMACOPŒIA.						
January	25–28	23–24	23–24	[1]48–50	48–50	48–50
April	16–17	23–24	23–25	[1]48–50	48–50	48–50
July	23–24	23–24	[1]36–40	48–50	48–50	48–50
October	23–24	23–24	[1]48–50	48–50	48–50	48–50

[1] Nominal.

Saltpeter (potassium nitrate), prices (wholesale) spot, New York, per pound.

[From Oil, Paint, and Drug Reporter, New York.]

	Crude.	Refined.		Crude.	Refined.
	Cents.	*Cents.*		*Cents.*	*Cents.*
January, 1912	4½–5	4½–6	January, 1915		7– 8
April, 1912	4½–5	4½–6	April, 1915		12–12½
July, 1912	4½–5	5 –6¼	July, 1915	40	17
October, 1912	5	5½–6½	October, 1915	39–41	18–19
January, 1913	5	5½–6½	January, 1916	65–70	35–38
April, 1913	5	5½–6½	April, 1916		35–38
July, 1913	5	5½–6½	July, 1916		30–31
October, 1913	4½–4¾	5½–6½	October, 1916		28–30
January, 1914	4½–4¾	5½–6½	January, 1917		31–35
April, 1914	4¾–5	4¾–5¾	April, 1917		31–38
July, 1914	4¾–5	4¾–5¾	July, 1917		31–38
October, 1914		9 –10			

	Granulated	Powdered.	Crystals.		Granulated.	Powdered.	Crystals.
	Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*
October, 1917	28	28½	32–33	July, 1919	15 –16	15¾–16½	16 –16½
January, 1918	28–28½	28½–29	31–31½	October, 1919	13½–14	14 –14¾	14½–16
April, 1918	28–28½	28½–29	31–31½	January, 1920	13¾–14½	14½–15½	14¾–16½
July, 1918	27–27½	27½–28	31–31½	April, 1920	13¾–14½	14½–15½	14¾–16½
October, 1918	27–27½	27½–28	31–31½	July, 1920	13½–14½	14½–15½	14¾–16½
January, 1919	27–27½	27½–28	31–31½	October, 1920	13¾–15½	15¼–16¾	14¾–17
April, 1919	24–24½	24¾–25¼	25–25½				

Rates of duty.

NITRATE OF SODA.

Act of— Year.	Act of— Paragraph	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	630	Soda, nitrate of, or cubic nitrate	Free.
1890	709	....do	Do.
1894	621	....do	Do.
1897	665	....do	Do.
1909	677	....do	Do.
1913	605	....do	Do.

NITRATE OF POTASH.

1883	68	Potash, nitrate of, or saltpeter, crude	1 cent per pound.
	69	Potash, nitrate of, or refined saltpeter	1½ cents per pound.
1890	685	Nitrate of potash, or saltpeter, crude	Free list.
	72	Potash, nitrate of, or saltpeter, refined	1 cent per pound.
1894	595	Nitrate of potash, or saltpeter, crude	Free list.
	56	Potash, nitrate of, or saltpeter, refined	½ cent per pound.
1897	644	Nitrate of potash, or saltpeter, crude	Free list.
	65	Potash, nitrate of, or saltpeter, refined	¼ cent per pound.
1909	655	Nitrate of potash, or saltpeter, crude	Free list.
	63	Nitrate of potash, or saltpeter, refined	¼ cent per pound.
1913	580	Potash, nitrate of, or saltpeter, crude	Free list.
	64	Potash, nitrate of, or saltpeter, refined	$7 per ton.

NITRITE OF SODA.

[Not mentioned specifically prior to the act of 1897.]

1897	76	* * * nitrite of soda	2½ cents per pound.
1909	73	....do	2 cents per pound.
1913	67	Soda, * * * and nitrite of	½ cent per pound.

CALCIUM NITRATE.

[Not mentioned specifically prior to 1913.]

1913	440	Calcium nitrate	Free list.

COURT AND TREASURY DECISIONS.

Nitrite of soda was held dutiable under the act of 1883 as a chemical salt and not exempt from duty as nitrate of soda or cubic nitrate. (G. A. 733, T. D. 11558; Appeal, T. D. 9457.)

SODIUM PHOSPHATE.

[Par. 67, act of 1913. ¼ cent per pound.]

Summary table.[1]

Year.	Domestic production (calendar years).	Imports for consumption (fiscal years).	Ratio to production, imports.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity (pound).	Equivalent ad valorem rate.
	Pounds.	*Pounds.*	*Per cent.*				
1910		62,193		$1,045	$261.00	$0.017	25.00
1911		43,868		750	188.00	.017	25.00
1912		(2)		(2)	(2)	(2)	(2)
1913		30		14	3.50	.467	25.00
1914	30,794,000	1,364,767	4.43	[3] 24,967	[3] 3,412.00	[3] .018	[3] 13.67
1915		485,300		7,765	1,213.00	.016	15.62
1916		1,066		79	2.67	.074	3.38
1917	26,610,000	1,561	(4)	521	3.90	.333	.75
1918	31,240,000	112		69	.28	.616	.41
1919	29,520,000						

[1] Domestic exports not listed separately in Commerce and Navigation.
[2] Not shown.
[3] From Oct. 4, 1913, to June 30, 1914.
[4] Negligible.

General Information.

Description.—There are a number of sodium phosphates known which can be distinguished by chemical means. The most important of these and the one most common in commerce is disodium phosphate (Na_2HPO_4). This compound is also shown as neutral phosphate, secondary phosphate, and is usually the phosphate meant when simply the designation sodium phosphate is used. This phosphate is ordinarily employed for various technical uses, as it is more stable than the other phosphates. It is very soluble in water and crystallizes from its aqueous solutions in large prisms containing twelve molecules of water. These crystals on exposure to air gradually lose their water of crystallization. If sodium phosphate is crystallized from a solution at a temperature above 30 ° C. crystals containing only seven molecules of water are obtained which do not lose their water on exposure to the air. Crystals of sodium phosphate melt at 30° C., losing all of their water of crystallization at 100° C. On further heating sodium phosphate decomposes into sodium pyrophosphate, the decomposition being complete at 300° C.

Sodium phosphate suitable for pharmaceutical purposes "contains not less than 39.25 per cent nor more than 44 per cent of anhydrous sodium phosphate (disodium orthophosphate) corresponding to not less than 99 per cent of the crystallized salt."

Uses.—Sodium phosphate is used in the textile industries, especially the silk industry, in the weighting of the material in dyeing. It is also used in the preparation of enamels and in tinning and soldering. It also has important pharmaceutical uses, as a product can be obtained

in the pure state and free from arsenic which is very desirable for this purpose. Sodium phosphate has an important use in analytical chemistry. Its chief use is in the manufacture of baking powders.

Of the other sodium phosphates the following may be mentioned:

Trisodium phosphate (Na_3PO_4). This is also known as the basic or tertiary phosphate. This salt was manufactured in the United States during 1917, according to the reports of the United States Geological Survey.

Monosodium phosphate (NaH_2PO_4), which is also known as primary or acid phosphate.

Double salts of sodium phosphate are frequently found. One of the most important of these is sodium ammonium phosphate or microcosmic salt, which has important analytical uses.

Domestic production and consumption.—Sodium phosphate may be obtained from dicalcium phosphate by treatment with soda ash. On a commercial scale it is usually prepared directly from bone ash or phosphorite. Either of these materials is digested in sulphuric acid for a considerable length of time, thus forming a solution of phosphoric acid and monocalcium phosphate. This solution is concentrated, filtered, and the neutral sodium phosphate allowed to crystallize from the solution.

The production of sodium phosphate in 1914, as reported by the census, was 15,397 short tons, valued at $853,528. The Geological Survey reported the production of sodium phosphate in 1917 as 13,305 short tons, valued at $711,283, which is less than the 1909 production. The output during 1919 was 14,760 short tons, valued at $1,733,996, a slight decrease from 1918. The domestic production practically supplies our consumption as the import of sodium phosphate is small. In 1914, even with an abnormal importation, the import was less than 5 per cent of the domestic production. The imports since then have declined greatly until in 1918 only 112 pounds came in.

The price of phosphate of soda increased from a normal prewar price of 2.1 cents per pound to a maximum of 7 to 8 cents in the latter half of 1916. The price in 1917 was constant at 6 to 7 cents per pound, in 1918 at 4 to 4½ cents, and in April, 1919, the price was 3¼ to 3½ cents per pound.

Tariff history.—Phosphate of soda was first mentioned by name in the act of 1913 as dutiable at one-fourth cent per pound. It had previously been dutiable at 25 per cent ad valorem as a chemical compound. The duty of one-fourth cent per pound has been equal to about 14 per cent ad valorem at normal prices ($0.017), as compared with the former duty of 25 per cent. The ad valorem equivalent since 1915 has decreased to as low as 0.41 per cent, owing to the high prices during the war.

Sodium phosphate—Production in United States.

OFFICIAL SOURCE.

[From Federal census.]

Year.	Quantity.	Value.
	Short tons.	
1899	2,340	$155,989
1904	4,830	244,373
1909	12,290	540,282
1914	15,397	853,528

OTHER SOURCES.

[From Geological Survey.]

	Short tons.	
1917	13,305	$711,283
1918	15,620	1,427,947
1919	14,760	1,733,996

Phosphate of soda—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	25 per cent					25.00
1908	do	25,381	$619	$154	$0.024	25.00
1909	do	49,153	707	176	.014	25.00
1910	do	62,192	1,045	261	.017	25.00
1911	do	43,868	750	187	.017	25.00
1913	do	30	14	3	.467	25.00
1914	¼ cent per pound	1,364,767	24,967	3,411	.018	13.67
1915	do	485,300	7,765	1,213	.016	15.62
1916	do	1,066	79	2	.074	3.38
1917	do	1,561	521	3	.333	.75
1918	do	112	69		.616	.41

Phosphate of soda, commercial, prices, wholesale, cents per pound.

[From Oil, Paint, and Drug Reporter.]

January, 1912	2 1/16–2 2/16	July, 1916	7 –8
April, 1912	2 1/16–2 2/16	October, 1916	7 –8
July, 1912	2 1/16–2 2/16	January, 1917	6 –7
October, 1912	2 1/16–2 2/16	April, 1917	6 –7
January, 1913	2 1/16–2 2/16	July, 1917	6 –7
April, 1913	2 1/16–2 2/16	October, 1917	6 –7
July, 1913	2 1/16–2 2/16	January, 1918	4 1/2–7
October, 1913	2 1/16–2 2/16	April, 1918	4 –4 1/2
January, 1914	2 1/16–2 2/16	July, 1918	4 –4 1/2
April, 1914	2 1/16–2 2/16	October, 1918	4 –4 1/2
July, 1914	2 1/16–2 2/16	January, 1919	4 –4 1/2
October, 1914	2 1/2 –2 3/4	April, 1919	3 1/2–3 3/4
January, 1915	2 1/2 –2 3/4	July, 1919	3 1/2–3 3/4
April, 1915	2 1/2 –2 3/4	October, 1919	3 1/2–4
July, 1915	2 1/2 –2 3/4	January, 1920	4 –4 1/2
October, 1915	2 1/2 –2 3/4	April, 1920	4 –4 1/2
January, 1916	2 1/2 –2 3/4	July, 1920	4 1/2–5
April, 1916	5 1/2 –6		

Phosphate of soda—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	92	* * * and all chemical compounds and salts, by whatever name known, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	76	* * * and all chemical compounds and salts, not specially provided for in this act.	Do.
1894	60	do	Do.
1897	3	do	Do.
1909	3	* * * and all chemical compounds, mixtures, and salts, * * * not specially provided for in this section.	Do.
1913	67	Soda: * * * phosphate of	¼ cent per pound.

SODIUM SILICATE.

Par. 605, act of 1913. Free. Includes silicic acid, par. 38..

SUMMARY.

Description.—Silicate of soda, "water glass" or "soluble glass," is a chemical compound produced from silica (sand) and an alkali salt, usually soda-ash. It is marketed mostly in water solutions but also to some extent as a solid. Silicate of soda is used chiefly as an adhesive in the manufacture of various forms of fiber and paper board and as a "filler" in the manufacture of soap.

Silicic acid as used in commerce is silicic acid anhydride or silica. It is either the product precipitated from alkaline solutions of silicate of soda, which is a white, bulky, amorphous powder, or it is natural forms of silica (quartz, flint, sand, infusorial earth).

Domestic production.—The production of silicate of soda has increased from 34,170 short tons in 1909 to 169,049 short tons in 1914 and 254,011 short tons in 1917. There was a further increase in 1918 and 1919. The output for 1919 was 300,138 short tons, valued at $5,879,628. The production of silicate of soda in terms of the ordinary 40° Baumé grade has been estimated by one of the large manufacturers as 295,000 short tons in 1917 and 335,500 tons in 1918. This increase is probably due to the large increase in the uses of silicate of soda, as the imports have been small and have shown no marked decrease.

The domestic production has practically supplied our consumption, as the imports have not amounted to more than 1.5 per cent of our production. Since the outbreak of the war this country has developed an export trade in silicate of soda which during the fiscal year 1918 amounted to 13,064 short tons, valued at $375,110. Prior to 1918 no exports of silicate of soda are shown in Commerce and Navigation.

The materials necessary for the manufacture of silicate of soda are a pure grade of silica (usually white quartz sand) and an alkali, usually soda-ash.

The process is simple and may be carried out with comparatively inexpensive equipment. In order to secure the physical properties necessary for some of its uses, however, considerable accuracy in composition is required, needing large equipment and much technical skill.

The industry is apparently rather widespread. It would seem better policy to locate manufacturing plants near the large markets, since it would be more economical to ship the sand and soda-ash instead of a water solution of silicate of soda.

Foreign production.—Figures on foreign production are not available. Germany prior to the war exported between 14,000 and 17,000 short tons per year.

Imports.—The imports of silicate of soda have been practically constant at about 700 short tons per year. This quantity has been less than 1.5 per cent of our domestic production.

The imports of silicic acid have been small and sporadic. There were no imports in 1917 or 1918.

Prices.—The prevailing price of the 40° Baumé liquid grade of silicate of soda in buyers' tank cars, f. o. b. plant has increased from 42½ cents per 100 pounds in 1915 to $1.35 for 1919. The price of "solid" silicate is about 2½ times the price of the 40° liquid.

Tariff history.—Silicate of soda was first mentioned in the act of 1890 as dutiable at ½ cent per pound. This same duty was in force during the act of 1897. The acts of 1894 and 1909 levied a duty of ⅜ cent per pound. The act of 1913 placed silicate of soda on the free list.

Silicic acid was first mentioned in the act of 1897 and has been on the free list since that time.

Silicate of soda—Summary table.

Fiscal year.	Domestic production, calendar year.	Imports for consumption, fiscal year.[1]	Domestic exports, fiscal year.	Ratio of imports to production.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
				Per cent.				*Per cent.*
1909	34,170	509	.....	1.49	.....	.....	.....	.....
1911	.....	617	.....	.....	$11,713	$4,630	$0.009	39.53
1912	.....	466	.....	.....	8,870	3,500	.009	39.45
1913	.....	516	.....	.....	9,400	3,870	.009	41.17
1914	169,049	523	.....	.31	10,881	(2)	.011	(2)
1915	.....	799	.....	.....	16,292	.....	.010	.....
1916	.....	784	.....	.....	18,694	.....	.012	.....
1917	254,011	602	.....	.23	18,493	.....	.015	.....
1918	317,161	354	13,064 [3] 14,125	.....	12,734	.....	.018	.....
1919	300,138	337	[3] 12,150	.....	16,647	.....	.025	.....

[1] Short tons of 2,000 pounds.
[2] From July 1 until Oct. 3, 1913, imports valued at $3,609, with duties collected of $1,105, which was equivalent to 30.61 per cent ad valorem. Beginning Oct. 4, silicate of soda was free of duty.
[3] Calendar years.

General Information.

DESCRIPTION.

The articles discussed in this survey are mentioned as follows in the tariff act of 1913.

Par. 605. "Soda, * * *, silicate of" (free list).

Par. 387. "Acids: * * *, silicic," (free list).

Silicate of soda is a chemical compound which is produced from silica (SiO_2) and an alkali salt, soda ash, caustic soda, and to some extent sodium sulphate. The composition of the commercial product is variable so as to secure the properties required in the several applications. The common grade approaches the composition expressed by the chemical formula $Na_2O—3\ SiO_2$ and contains about 76 per cent of silica. In the solid fused form it is very similar to glass in appearance, and under certain conditions it is soluble in water, which accounts for the commercial designations of "soluble glass" and "water glass."

The larger part of the silicate of soda is marketed in water solutions of various composition. Solutions of silicate of soda are usually

alkaline, the alkalinity of the solution tends to hold the silica in solution. The degree of alkalinity varies from slightly alkaline to strongly alkaline depending on the purpose for which the silicate is intended. A small portion of silicate is marketed as a solid in the form of whole or broken plates about 2½ inches square and ½ inch thick, as lumps and as a powder. There are special brands of both the solid and liquid silicate of soda which are marketed by the different manufacturers.

The solutions of silicate of soda are easily decomposed by acids, even carbonic acid (carbon dioxide), with the precipitation of gelatinous silica.

Silicic acid as used in commerce refers to silicic acid anhydride or silica. This silica may be that precipitated from solutions of silicate of soda by means of a mineral acid, or it may be natural forms of pure silica (quartz, flint, white sand, chalcedony, opal, agate, and infusorial earth). Therefore the term as used in commerce does not mean an acid, but an acid anhydride.

The precipitated product is a snow-white bulky amorphorus powder soluble in hot alkaline solutions with the formation of sodium silicate. The natural forms are only partially soluble in hot alkalis, but when fused with alkali they form soluble sodium silicate.

IMPORTANT USES.

Silicate of soda has acquired an increasing number of uses. The following gives the estimated distribution for 1918:

	Per cent.	Per cent.
Abrasive wheels		0.2
Asbestos products		3.4
Boiler compound		.7
Cements		1.4
Miscellaneous		5.9
Paper industry including:	Per cent.	
Corrugated fiber board	27.4	
Solid fiber board, Wall board	13.3	
Coating paper board	1.0	
Sealing fiber-board containers	2.0	
		43.7
Paper sizing		1.3
Silk weighting		2.7
Soap		38.4
Veneers		2.3
		100.0

A. As an adhesive it is used in the manufacture of paper board, fiber board, wall board, paper tubes, asbestos-pipe coverings, veneer panels, trunks and bags, and in sealing shipping containers.

B. It is used as a binder in the manufacture of abrasive wheels, stove and furnace cements, digester linings, acid-proof cements, artificial building stone, cold-water paints, and as a road binder. It is used in making cements for repairing broken china and porcelain.

C. It is used to close up porous surfaces and to form protective or preservative coatings, in lining wooden packages, grease-proofing paper board, dust-proofing concrete floors, waterproofing concrete, fireproofing wood, cloth, and paper, sizing fertilizer bags. A solu-

tion of silicate of soda is used for preserving eggs, which is a large domestic use.

Paper when containing silicate of soda does not have the attraction for vermin that paper containing glue or paste possesses.

D. Silicate of soda is used for "filling" in the manufacture of alkali laundry soaps. This is the original use and one of the largest uses. The silicate of soda tends to produce a harder soap and has limited detergent properties, due to the alkali contained in the silicate of soda. However, there is a tendency on the part of unscrupulous manufacturers to add silicate of soda in quantities, which constitute adulteration and thus lower the value of the soap.

E. It is used as an ingredient of boiler compounds, for sizing paper, and for stain proofing lumber.

F. In the textile industry it is used in peroxide bleaching, in the kier boiling of cotton goods, and in the weighting of silk.

PROCESS OF MANUFACTURE.

The raw materials used in the manufacture of sodium silicate or water glass are silica (usually white sand washed or a sand rock ground and washed) and an alkali. Soda ash is usually used, although sulphate of soda is used to a certain extent.

"Dry process."—In this process silicate of soda is produced by fusing powdered quartz or white sand with soda ash in a furnace at a temperature of about 1,000° C. The fused product is then run into an iron receptacle, where it is allowed to cool and solidify. The solid silicate of soda is then broken by means of crushers and marketed in the lump form or it is pulverized and dissolved by boiling with hot water, preferably under pressure. The solution is then allowed to clarify by settling, and is finally evaporated to the required density of about 40° Baumé. This method is generally used in this country, and the majority of silicate is sold in the liquid form.

A water glass known as "double soluble glass" and containing about equal proportions of sodium and potassium silicates is prepared by using the proper quantities of potassium and sodium carbonates. This product is not in general use, owing to the high cost of the potassium carbonate.

Plants for the production of silicate of soda are usually built near the point of consumption rather than near the source of the raw materials. It is more economical to ship the sand and soda ash than the finished water solution of silicate. Only a small portion of the production of soda is sold in the solid form, owing to the difficulty of dissolving small quantities to a uniform consistency.

Silicate of soda—Production in United States.

OFFICIAL SOURCE.

[From Federal Census.]

Year.	Quantity.	Value.
	Short tons.	
1899	32,651	$416,005
1904	(1)	(1)
1909	34,170	366,621
1914	169,049	1,648,854

[1] Not available.

Silicate of soda—Production in United States—Continued.

OTHER SOURCES.

[From Geological Survey.]

Year.	Quantity.	Value.
	Short tons.	
1917	254,011	$3,317,547
1918	317,16	5,870,973
1919	300,138	5,879,628

NOTE.—The production of silicate of soda has been estimated by the Philadelphia Quartz Co. on the basis of the ordinary 40° B. product as 295,000 short tons in 1917 and 335,500 short tons in 1918

Silicic acid—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	Free	50	$8		$0.160	
1909	do	6,553	353		.054	
1910	do	1,430	198		.128	
1911	do	11,698	242		.021	
1912	do	8,897	507		.057	
1913	do	121,344	6,486		.053	
1914	do					
1915	do	3,086	586		.190	
1916	do	15	6		.400	

Silicate of soda—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	½ cent per pound	1,488,017	$13,376	$7,440	$0.009	55.62
1909	do	1,018,243	8,578	5,091	.008	59.35
1910	do	124,342	1,150	621	.009	54.06
	⅛ cent per pound	1,074,821	11,844	4,030	.011	32.32
1911	do	1,234,721	11,713	4,630	.009	39.53
1912	do	933,236	8,870	3,499	.009	39.45
1913	do	1,032,113	9,400	3,870	.009	41.17
1914	do	294,630	3,609	1,104	.012	30.61
	Free	751,939	7,272		.010	
1915	do	1,587,902	16,292		.010	
1916	do	1,567,617	18,694		.012	
1917	do	1,203,844	18,493		.015	
1918	do	707,583	12,734		.017	
1919	do	673,717	16,647		.025	

Silicate of soda—Domestic exports—Calendar years.

Exported to—	1918 [1]		1919		1920 (9 months).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Canada	23,309,140	$253,132	20,604,420	$205,700		
Mexico	1,007,411	36,587	772,939	28,229		
Cuba	1,209,050	29,058	742,405	19,586		
Argentina	19,687	759	114,599	4,594		
Brazil	88,840	3,265	179,206	8,218		
Chile	195,962	5,430	106,764	4,525		
Columbia	19,366	875	178,993	7,121		
Venezuela	316,479	13,966	230,810	8,393		
China	114,608	2,446	361,793	15,435		
Hongkong	171,271	4,116	124,212	6,313		
Japan	108,133	7,780	64,356	1,662		
Australia	164,776	5,407	255,518	10,170		
All other	1,525,637	41,975	564,552	18,872		
Total	28,250,360	404,796	24,300,567	338,818	28,404,678	$356,649

[1] Not listed separately prior to 1918.

PRICES.[1]

The best comparison of prices is made by using the price under contract of the 40° B. solution in buyer's tank car f. o. b. This gives a "naked" value to which successive differentials are added for seller's tank car service, use of seller's drums, the value of wooden barrels, etc. Contracts mostly are closed covering the buyer's requirements for consumption during 12 months. The following figures represent the prices of the largest single manufacturer:

Prevailing price per hundred pounds, f. o. b. in buyer's tank car, 40° B. solution: 1915, 42½ cents; 1916, 45 cents; 1917, 60 cents; 1918, 85 cents; 1919, $1.35.

The price of "solid silicate of soda usually is about two and one-half times that of the "naked" 40° liquid, as 1 pound of the "solid" will produce approximately 2½ pounds of the 40° liquid, although manufacturers consider the additional difficulties of producing the solid gives it an additional value when this can be obtained.

Silicate of soda—Prices (wholesale), spot, New York.[1]

[From Oil, Paint, and Drug Reporter.]

	1912	1913	1914	1915	1916
Liquid:					
January	$0.65–$1.50	$0.65–$1.50	$0.65–$1.50	$0.85–$1.10	$0.85–$1.10
April	.65– 1.50	.65– 1.50	.65– 1.50	.85– 1.10	1.25– 1.50
July	.65– 1.50	.65– 1.50	.65– 1.50	.85– 1.10	1.25– 1.50
October	.65– 1.50	.65– 1.50	.90– 1.25	.85– 1.10	1.00– 1.50
Crystal:					
January	.02– .02½	.02– .02½	.02– .02½	.02– .02½	.02– .02½
April	.02– .02½	.02– .02½	.02– .02½	.02– .02½	.02– .03
July	.02– .02½	.02– .02½	.02– .02½	.02– .02½	.02– .03
October	.02– .02½	.02– .02½	.02– .02½	.02– .02½	.02– .03

	1917	1918	1919	1920
Liquid:		*40 degrees.*[1]	*40 degrees.*[1]	*40 degrees.*[1]
January	$1.25 –$1.50	$0.02½	$0.01½–$0.02½	$1.12–$1.25
April	2.00 – 2.25	.02½	.02 – .02½	1.10– 1.25
July	2.00 – 2.25	.02½– .02½	.02 – .02½	1.20– 1.30
October	2.00 – 2.25	.02½	.01½– .02½	1.15– 1.20
Crystal:		*60 degrees.*[1]	*60 degrees.*[1]	*60 degrees.*[1]
January	.01½– .02½	$0.04	$0.05 –$0.05½	$2.75–$3.00
April	.02½– .02½	$0.04½– .05	.04 – .04½	2.90– 3.10
July	.02½– .02½	.05	.03 – .03½	2.80– 2.90
October	.02½– .02½	(2)	.03 – .03½	2.85– 3.00

[1] Quotations changed to 40-degree product and 60-degree product.
[2] Nominal.

NOTE.—Quotations for liquid per 100 pounds, until 1918, then cents per pound. Quotations for crystal are cents per pound throughout.

[1] Submitted by the Philadelphia Quartz Co., Philadelphia, Pa.

Silicate of soda (par. 605, act of 1913, free)—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	.....	Not mentioned.	
1890	84	Silicate of soda, or other alkaline silicate	¼ cent per lb.
1894	68	.....do	¼ cent per lb.
1897	79	.....do	¼ cent per lb.
1909	76	.....do	¼ cent per lb.
1913	605	Soda, silicate of	Free list.

Silicic acid[1] *(par. 387, act of 1913, free)—Rates of duty.*

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	464	Acids, silicic	Free list.
1909	482	.....do	Do.
1913	387	.....do	Do.

[1] Not mentioned specifically prior to 1897.

EXPORTS OF SILICATE OF SODA FROM GERMANY.[1]

Year.	Short tons.	Value.
1909	14,275	$169,456
1910	14,860	176,358
1911	16,110	236,576
1912	16,537	242,760
1913	17,133	220,626

[1] From Vierteljahrshefte zur Statistik des Deutschen Reich.

SODIUM SULPHATE, CRUDE (SALT CAKE AND NITER CAKE).

[Par. 605, act of 1913. Free.]

SUMMARY.

Salt cake (sulphate of soda, crude) is the impure sodium salt of sulphuric acid. It occurs in nature and is obtained to some extent from these natural sources. Salt cake is obtained chiefly by chemical processes.

Salt cake is used in this country in the manufacture of the cheaper grades of window and bottle glass, ultramarine, and sodium sulphide manufacture.

Niter cake is the sodium acid salt of sulphuric acid. It is obtained as a by-product from the manufacture of nitric acid.

Niter cake is used as a substitute for sulphuric acid and in the manufacture of muriatic acid.

The imports of salt cake and niter cake decreased from $121,218 in 1911 to $6,392 in 1916. The imports of salt cake and niter cake together in 1914 amounted to 231 short tons, as compared with the domestic production of 90,442 short tons of salt cake in 1914, or less than 1 per cent.

The price of salt cake had been steady since 1912 at 55 to 65 cents per hundred pounds until 1917, when it increased to 75 cents per hundred pounds.

Salt cake and niter cake are on the free list of the act of 1913. The imports since this act was passed have not increased, and no appreciable revenue would be obtained by imposing a duty on either commodity.

The rates on these commodities varied from 20 per cent ad valorem to a specific rate of $1.25 per ton before the act of 1913.

Soda, sulphate of, crude, or salt cake and niter cake (par. 605, act of 1913, free)—Summary table.

Year.	Domestic production.	Imports for consumption.	Ratio to production (per cent), imports.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
	Short tons.	*Short tons.*					*Per cent.*
1910	.....	3,927	.....	$40,640	$3,927	$10.35	9.67
1911	.....	11,398	.....	121,218	11,398	10.64	9.40
1912	.....	658	.....	8,394	658	12.76	7.85
1913	.....	189	.....	4,771	189	25.24	3.96
1914	[1] 90,442	206	0.24	2,436	28	11.82	4.53
1915	.....	189	.....	3,566	.....	18.87	Free.
1916	.....	91	.....	6,392	.....	70.24	Do.
1917	[2] 571,730	216	.....	4,122	.....	19.08	Do.
1918	284,209	463	.....	8,382	.....	18.10	Do.
1919	218,087	28	.....	166	.....	6.00	Do.

[1] For salt cake only.
[2] Includes both salt cake and niter cake from 1917 on.

General Information.

DESCRIPTION.

Sulphate of soda, crude, is the impure sodium salt of sulphuric acid. It occurs in nature both in the anhydrous state as Thenardite and as a crystallized salt, Mirabilite; also in combination with calcium sulphate as Glauberite, as a constituent of natural soda, dissolved in mineral waters, sea water, etc. It is obtained to some extent from these natural sources, but chiefly by chemical processes. When made from salt by the action of sulphuric acid or niter cake, and in an impure form, it is usually called "salt cake." By a process of purification and crystallization this impure salt is converted into a pure hydrated crystalline form, which is called "Glauber's salt." (See Tariff Information Survey—Glauber's Salt.)

Niter cake is a by-product obtained in the manufacture of nitric acid from sodium nitrate and sulphuric acid. It consists chiefly of sodium acid sulphate, with a varying amount of sodium sulphate or free sulphuric acid, together with other impurities, such as nitric acid, chlorides, iron, and traces of iodine in the form of iodates.

PROCESSES OF MANUFACTURE.

Sodium sulphate is obtained commercially from three sources:

(1) Natural deposits or brine lakes. It is obtained from this source chiefly as a by-product in the recovery of the more valuable potash salt, which is present in such brines.

(2) By the action of sulphuric acid or niter cake on salt. In the United States salt cake may be regarded as a by-product of the manufacture of muriatic acid. In Europe, although made by the same process, the demand for salt cake for use in the manufacture of "soda" (soda ash) by the Leblanc process is so great that the muriatic acid may be regarded as the by-product.

(3) From salt and sulphur dioxide, air and steam, by the Hargreaves-Robinson process. This process is used in Europe but not in the United States.

USES.

Salt cake is used in the manufacture of the poorer grades of glass, especially bottles, since it is a cheaper source of sodium than soda ash.[1] It is used for the manufacture of sodium sulphide and Glauber's salt, also ultramarine.

In Europe it is used for the manufacture of soda ash by the Leblanc process, but it is not so used in the United States.

The war has stimulated the increased use of niter cake. The great increase in the manufacture of nitric acid has resulted in the production of greatly increased amounts of niter cake. At the same time the increased need for sulphuric acid in the manufacture of explosives has made it necessary to substitute niter cake for sulphuric acid wherever possible.

[1] For a high-grade glass, soda ash is preferable to salt cake on account of the fact that a colorless glass is more readily produced by the use of soda ash.

These new uses include—for acidifying soap stock, as an acid wash, regenerating plaster, acidifying phosphatic fertilizer, in the manufacture of conditioners, bleaching paper pulp, preparing muriatic acid, acidifying naphtholates and phenolates, recovering grease, carbonizing (in shoddy mills), as a flux, pickling (in tanning), removing oxid and scale, defiberizing rubber stock, souring (in textile mills), and for many other uses.

STORAGE AND SHIPMENT.

Salt cake is dried to the anhydrous condition before being shipped. Niter cake, due to the sulphuric acid content, is not usually packed in metal containers but is shipped either in bulk or packed in wooden-stave barrels. Niter cake as it comes from the nitric acid retorts is in a molten condition, and when not intended for immediate shipment is run out on the ground to solidify, forming niter cake "lakes." The neutral sodium sulphate or salt cake can be stored in the ordinary containers or wooden bins.

COMPETITIVE CONDITIONS.

Salt cake is a by-product from the manufacture of muriatic acid in the United States. The process of manufacturing muriatic acid in this country uses very cheap raw materials, namely, niter cake and salt. Both of these raw materials are produced in large quantities in the United States. In Europe, although made by the same process, the demand for salt cake for use in making soda ash is so great that the muriatic acid may be regarded as the by-product. The manufacture of soda ash is by far the most important use of salt cake, but it is not so used in the United States. Salt cake is used in this country chiefly in the manufacture of window glass and cheaper grades of bottle glass.

Niter cake is produced in large quantities in this country from the manufacture of nitric acid. As it is very corrosive, due to the acid content, it is not safe to ship it in metal containers. This article can be shipped short distances in old freight cars in bulk or in wooden-stave barrels.

Salt cake—Production in United States.

[From United States Geological Survey.]

	Salt cake.		Niter cake.	
	Short tons.	Value.	Short tons.	Value.
1917	183,909	$2,987,641	387,821	$780,278
1918	141,054	2,844,897	143,155	595,660
1919	134,685	2,035,543	83,402	271,424

NOTE.—No figures given for the years previous to 1914.

Salt cake—Exports of the United Kingdom.

Countries.	1910		1911		1912	
	Quantity.[1]	Value.	Quantity.	Value.	Quantity.	Value.
Russia	4,789	$29,661	7,552	$57,181	7,435	$49,298
Sweden	17,696	109,165	20,884	153,436	19,142	141,815
Norway	7,958	55,040	7,995	62,612	9,335	70,287
Belgium	11,851	64,097	12,737	88,385	8,231	49,200
United States	10,695	105,092	5,127	52,568	.....	.....
Total foreign	58,192	412,626	60,176	476,051	50,544	374,278
Total British	6,800	66,559	5,675	55,249	5,407	52,359
Grand total	64,991	479,185	65,852	531,300	55,952	426,636

Countries.	1913		1914		1915	
	Quantity.[1]	Value.	Quantity.	Value.	Quantity.	Value.
Russia	11,570	$81,918	3,857	$29,296	2,939	$15,524
Sweden	27,391	203,439	16,811	129,673	10,978	64,325
Norway	9,794	82,166	7,761	62,754	3,395	22,673
Belgium	14,095	87,636	6,423	40,085	.....	.....
Total foreign	70,371	516,847	41,089	314,439	25,044	174,415
Total British	3,823	38,041	3,263	30,605	10,138	106,586
Grand total	74,194	554,888	44,351	345,045	35,183	281,001

Countries.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Russia	11	$973	.....	.....	.....	.....
Sweden	10,843	79,689	.....	.....	.....	.....
Norway	7,275	54,953	6,572	$58,666	.....	.....
Total foreign	25,646	207,454	12,479	140,569	.....	.....
Total British	1,427	20,264	10,746	148,861	.....	.....
Grand total	27,073	227,718	23,225	289,430	.....	.....

[1] Quantities are in short tons of 2,000 pounds.

Salt cake and niter cake—Exports of Germany.

Exported to—	1909		1910		1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*		*Short tons.*	
Belgium	47,317	$306,544	62,915	$407,694	54,649	$360,094	46,913	$313,684	47,425	$320,110
Austria-Hungary	10,340	67,116	11,052	71,876	11,738	99,722	15,162	129,948	14,005	121,856
All other	24,478	158,270	25,581	165,172	31,981	286,076	32,079	312,494	29,332	302,736
Total	82,135	531,930	99,548	644,742	98,368	745,892	94,154	756,126	90,762	744,702

Salt cake—Prices (wholesale), spot, New York.

[From Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.
1912 [1]	$0.55–$0.65	$0.55–$0.65	$0.55–$0.65	$0.55–$0.65
1913	.55– .65	.55– .65	.55– .65	.55– .65
1914	.55– .65	.55– .65	.55– .65	.55– .65
1915	.55– .65	.55– .65	.55– .65	.55– .65
1916	.55– .65	.60– .70	.....	.55– .65
1917	.75	.....	.....	1.50– 2.00
1918 [2]	30.00–35.00	30.00–35.00	30.00–35.00	35.00–40.00
1919	25.00–30.00	18.00–20.00	12.00–15.00	14.00–17.00
1920	17.00–21.00	21.00–25.00	40.00–45.00	50.00–60.00

[1] Price per 100 pounds, 1912 to 1917, inclusive. [2] Price per ton ground, 1918 to date.

Unground (per ton), 1918, January, $25–$26; April, $25–$26; July, $20–$25; October, $25–$30; 1919, January, $23–$28.

Soda, sulphate of, crude, or salt cake and niter cake—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Tons.				*Per cent.*
1908	$1.25 per ton	207	$2,169	$259	$10.44	11.97
1909	do	18	767	22	42.00	2.98
1910	$1 per ton	3,927	40,640	3,927	10.35	9.67
1911	do	11,398	121,218	11,398	10.63	9.40
1912	do	658	8,394	658	12.74	7.85
1913	do	189	4,771	189	25.23	3.96
1914	do	28	618	28	22.07	4.53
1914	Free	178	1,818	.....	10.21	.....
1915	do	189	3,566	.....	18.86	.....
1916	do	91	6,392	.....	70.24	.....
1917	do	216	4,122	.....	19.08	.....
1918	do	463	8,382	.....	18.10	.....

Soda, sulphate of, crude, or salt cake and niter cake—Rates of duty.

Act of—		Tariff classification or description.	Rates of duty, specific and ad valorem.
Year.	Par.		
1883	A	Soda: Sulphate, known as salt cake, crude or refined, or niter cake, crude or refined.	20 per cent ad valorem.
1890	85	* * *, or salt cake, or niter cake	$1.25 per ton.
1894	622	do	Free.
1897	80	do	$1.25 per ton.
1909	77	Sulphate of soda, or salt cake or niter cake	$1 per ton.
1913	605	Soda, sulphate of, crude, or salt cake and niter cake	Free.

Court and Treasury Decisions.

So-called salt cake was held dutiable as sulphate of soda or niter cake and not as waste under the act of 1890. (G. A. 1292. (T. D. 12643).)

Merchandise known as crude sulphide of sodium was declared not sulphate of soda, salt cake, or Glauber's salt of commerce, and hence not dutiable under the provision for such sulphates. It was classified under the provision in the act of 1883 for preparations known as alkalies, and chemical compounds and salts. (Appeal. T. D. 6188)

SODIUM SULPHATE, CRYSTALLIZED [GLAUBER'S SALT].

[Par. 67, act of 1913; $1 per ton.]

SUMMARY.

Description.—Sulphate of soda, crystallized, or Glauber's salt, is sodium sulphate combined with 10 molecules of water of crystallization. The crystals on exposure to the air lose their water, forming a white powder of sodium sulphate. Glauber's salts are used as an assistant in dyeing, for diluting dyes, and for the preparation of cooling mixtures.

Domestic production.—The manufacture of Glauber's salt is as a by-product of the production of hydrochloric and nitric acids. The residue left in the manufacture of these acids is used as the raw material for the production of Glauber's salt.

The production in the United States in 1914 amounted to 34,537 short tons, valued at $427,808. This quantity was a decrease over the 1909 production. The domestic production supplies nearly all of our consumption.

Imports.—The imports of Glauber's salt have never been large and have decreased until in 1917 they are not shown separately in commerce and navigation.

Prices.—The price of Glauber's salt has not increased in comparison with other chemicals, probably because it is a by-product and there is a superabundance of raw materials.

Tariff history.—Sulphate of soda, crystallized, or Glauber's salt, was first mentioned by name in the act of 1913 as dutiable at $1 per ton. Sulphate of soda has been mentioned since the act of 1890 and has been dutiable at $1 or $1.25 per ton, with the exception of the period covered by the act of 1894, when it was on the free list.

Sodium sulphate, crystallized, Glauber's salt—Summary table.[1]

Year.	Domestic production.	Imports for consumption.	Ratio of imports to production.	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
	Long tons.	*Long tons.*	*Per cent.*			*Long tons.*	*Per cent.*
1909	41,402						
1910		337		$6,484	$354	$19.24	5.46
1911		221		4,907	221	22.20	4.51
1912		239		4,810	239	20.13	4.98
1913		336		5,685	336	16.92	5 91
1914	30,836	227	0.73	5,657	227	24.92	4.03
1915		53		1,113	53	21.00	4.76
	Short tons.						
1916		1		33	1	33.00	3.03
1917	47,757	(2)		(2)	(2)	(2)	(2)
1918	50,715						
1919	42,087						

[1] Domestic exports not listed in Commerce and Navigation. [2] Not listed. [3] Not listed separately.

General Information.

Description.—Sulphate of soda or sodium sulphate, chemically, is composed of 32.4 per cent of sodium (Na) and 67.6 per cent of the sulphate group (SO_4). It crystallizes with 1, 2, 7, and 10 molecules of water. The crystals containing 10 molecules of water are the most common and is the "sulphate of soda, crystallized or Glauber's salt" as described in the tariff act of 1913, paragraph 67. Glauber's salt is composed of 14.3 per cent of sodium, 29.8 per cent of sulphate (SO_4), and 55.9 per cent of water. It crystallizes in large transparent crystals having a specific gravity of 1.471 and also in small fine crystals similar in appearance to Epsom salts. It has formerly been used to adulterate Epsom salts and even as a substitute for the same. The size of the crystals of Glauber's salt depends on the condition during the crystallization. Glauber's salt has a cooling, bitter, salty taste and is neutral in its chemical reaction. The crystals on exposure to the air lose all their water of crystallization (effloresce), forming a white powder of anhydrous sodium sulphate. When sodium sulphate crystals are dissolved in water there is a decrease in the temperature instead of a rise in temperature, which is the case when most chemical salts are dissolved.

Sodium sulphate if crystallized from a solution at a temperature above 33° C. forms crystals of the anhydrous sodium sulphate or the monohydrated salt. As a usual thing, the most of the sodium sulphate prepared for the market is in the anhydrous form and only a small part is converted into the crystallized Glauber's salt. It is certainly more economical to ship the anhydrous salt instead of the crystallized salt containing 10 molecules of water.

Sodium sulphate occurs in nature in the anhydrous form as the mineral "thenardite," as the crystallized salt "mirabilite," in combination with calcium sulphate as "glauberite," and also dissolved in mineral waters. In some places Glauber's salt is obtained from these natural sources on an industrial scale. Large deposits are found in Arizona, Spain, Peru, Hungary, Siberia, and Hawaii. Nearly all the natural deposits contain enough iron to make them unfit for the manufacture of glass, which is one of the large uses for sodium sulphate and is supplied in this country by "salt cake." (See report on "Salt cake.")

Important uses.—Glauber's salt is used as an assistant in dyeing, for diluting dyes to the commercial strength, in medicine, especially veterinary, and for the preparation of cooling mixtures. It is sometimes used as an adulterant in washing sodas. It has no cleansing properties and its use for this purpose is fraudulent. It was formerly used as an adulterant in Epsom salts and even as a substitute for the same.

For the uses of neutral sodium sulphate and salt cake see the report on "Salt cake."

Process of manufacture.—The production of Glauber's salt and anhydrous sodium sulphate in this country is a by-product of the manufacture of hydrochloric and nitric acids. The "salt cake" or "niter cake" which are residues left in the production of these acids is utilized as the raw material for the manufacture of Glauber's salt. The only other raw materials used are lime for neutralizing the acid

in the case of "niter cake" and soda ash for removing the calcium salts.

The salt or niter cake is first dissolved in hot water. This solution is then neutralized with "milk of lime" if need be and the calcium salts are then precipitated by the addition of soda ash. Any iron present is precipitated at the same time. This mixture is then filtered to remove the precipitates. The clear solution of sodium sulphate is then run into large coolers, where the sodium sulphate is allowed to crystallize out as Glauber's salt. If large crystals are desired the solution is allowed to cool slowly without agitation, while for the production of the small fine crystals the solution after cooling to about 30° is agitated either by stirrers or by compressed air. This method produces fine crystals similar in appearance to Epsom salts. If a pure Glauber's salt is desired the crystals from the first crystallization are "whizzed" in a centrifugal to remove the mother liquor and then recrystallized from pure water.

To produce the anhydrous sodium sulphate the clear solution of sodium sulphate is evaporated rapidly to dryness and the residue is calcined to remove all the water. This practice is usually followed, as a large part of the sodium sulphate is marketed in the anhydrous state instead of the crystallized Glauber's salt.

At Stassfurt, in Germany, during the winter time a large quantity of Glauber's salt is made from a solution containing magnesium sulphate and salt. This solution is a by-product of the extraction of potash from the Stassfurt deposits. At a temperature below 0° C. these two chemicals combine to form sodium sulphate and magnesium chloride. The sodium sulphate crystallizes out of the solution as Glauber's salt.

History of the industry.—Sodium sulphate was first described in 1658 by Glauber, who prepared it from the residue left in the manufacture of hydrochloric acid. This is identical with the method largely used at the present time. The crystallized sodium sulphate became known as Glauber's salt after its discoverer, and this name has been retained down to the present time. Crystallized sodium sulphate was first made on a large scale at Friedrichsshall in Germany from salt brine by the freezing-out method described above. It has been known since 1767 in Germany as "Friedrichssalz."

The production of Glauber's salt in the United States has always been in conjunction with the manufacture of hydrochloric acid or nitric acid. The quantity produced is not nearly sufficient to utilize all of the salt and niter cake. Thus there is an unlimited quantity of raw materials for this article.

Sodium sulphate (Glauber's salt)—Production in United States.

[From U. S. Geological Survey.]

Year.	Quantity.	Value.
	Short tons.	
1917	47,757	$732,403
1918	50,715	1,041,070
1919	42,087	860,977

Sulphate of sodium, or Glauber's salt—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Tons.				*Per cent.*
1907	$1.25 per ton	252	$4,974	$315	$19.77	6.32
1908	do	192	4,162	240	21.67	5.78
1909	do	178	4,391	222	24.67	5.07
1910	do	68	1,178	85	17.32	7.22
	$1.00 per ton	269	5,306	269	19.68	5.08
1911	do	221	4,907	221	22.20	4.51
1912	do	239	4,810	239	20.13	4.96
1913	do	336	5,685	336	16.91	5.91
1914	do	227	5,657	227	24.92	4.03
1915	do	53	1,113	53	21.00	4.76
1916	do	1	33	1	33.00	3.03

Glauber's salt—Prices, wholesale, per 100 pounds, spot, New York.

[From Oil, Paint, and Drug Reporter.]

	January.	April.	July.	October.
1912	$0.60–$0.90	$0.60–$0.90	$0.60–$0.90	$0.60–$0.90
1913	.60– .90	.60– .90	.60– .90	.60– .90
1914	.60– .90	.60– .90	.60– .75	.60– .75
1915	.60– .75	.60– .75	.60– .75	.60– .75
1916	.60– .75	.70– .80	.65– .70	.60– .65
1917	.60– .65	.60– .70	.65– .70	1.25
1918	.90– 1.00	1.50– 1.75	1.50– 1.75	2.00– 2.50
1919	1.75– 2.25	1.50– 2.00	1.00– 1.50	1.25– 1.50
1920	1.15– 1.50	1.60– 1.75	2.30– 2.45	2.10– 2.50

Sulphate of soda, crystallized, or Glauber's salt—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
	A	Soda:	
1883	75	Sulphate, * * * and Glauber's salt	20 per cent ad valorem.
1890	85	Sulphate of	$1.25 per ton.
1894	622	Do	Free.
1897	80	Do	$1.25 per ton.
1909	77	Do	$1 per ton.
1913	67	* * * and sulphate of, crystallized, or Glauber's salt	Do.

Court and Treasury Decisions.

Sulphate of sodium, invoiced as Karlsbader Salz crist, was held dutiable as sulphate of sodium under the act of 1890. (Abstract 13581 (T. D. 27734); G. A. 1292 (T. D. 12643).)

Sodium sulphate in a powdered form calcined was held dutiable as a chemical compound or mixture under the act of 1913 and not as included within the provision for "sulphate of soda crystallized, or Glauber salts," the term "Glauber salts" being restricted to the crystalline form. (G. A. 7864 (T. D. 36192); Abstract 39924.)

Merchandise known as crude sulphide of sodium was declared not sulphate of soda, salt cake, or Glauber's salt of commerce, and hence not dutiable under the provision for such sulphates. It was classified under the provision in the act of 1883 for preparations known as alkalies and chemical compounds and salts. (Appeal, T. D. 6188.)

SODIUM SULPHIDE.

[Par. 67, act of 1913. One-fourth cent per pound.]

SUMMARY.

Description.—Sulphide of soda is a chemical compound composed of sodium and sulphur. There are two commercial articles—the "crystal" sulphide of soda, containing about 30 per cent of sodium sulphide, and the "fused" or "concentrated," containing about twice as much sodium sulphide as the crystal product. Sulphide of soda is used chiefly in the manufacture and dyeing of sulphur colors and as a depilatory agent in leather manufacture.

Domestic production.—The production of sulphide of soda has increased from 7,673 short tons in 1909 to 20,263 short tons in 1914 and 49,494 short tons in 1917. There was a slight decrease in 1918, and in 1919 the output was 45,448 short tons, valued at $2,645,181. The increase from 1914 to 1917 is undoubtedly due to the new outlet created by the establishment of an American dyestuff industry.

The production in this country practically supplies our demand, as the imports are small in comparison.

Sulphide of soda was formerly manufactured from sodium sulphate (salt cake), which is a by-product of the manufacture of muriatic or hydrochloric acid. The war has caused the development of a barium chemical industry in this country, and sulphide of soda is obtained as a by-product of this industry. This is undoubtedly a large source at the present time (1918).

The manufacture of sulphide of soda is rather widespread, as it is produced in the following States: New York, Ohio, Missouri, Massachusetts, West Virginia, Tennessee, Pennsylvania, and California. It is probably produced in other States also.

Exports of domestic sulphide of soda are not shown in Commerce and Navigation.

Foreign production—There is no information available on the production of sulphide of soda in foreign countries. Germany was the leading producer of barium chemicals and therefore undoubtedly produced large quantities of sulphide of soda as a by-product for use in her dyestuff industry.

Imports.—The imports have been small compared with the domestic production. During 1914 the imports reached a maximum and were only 6.24 per cent of the production in this country. Imports are not shown by countries.

Prices.—The price of the 60 per cent fused sodium sulphide prior to about October, 1915, was nearly constant at 2½ cents per pound. The prevailing price during 1918 has been about double this amount.

The 30 per cent crystal sulphide of soda sold at about 1½ cents per pound prior to the war. The price has since increased to around 3 cents per pound in 1918.

Tariff history.—Sulphide of soda was first mentioned in the act of 1897 as dutiable at one-half cent per pound. The act of 1909 levied a duty based on the percentage content of sodium sulphide in the product. The duty was three-eighths cent per pound for a product containing not more than 35 per cent sodium sulphide and three-fourths cent per pound for a product containing more than 35 per cent of sodium sulphide. The act of 1913 made all sulphide of soda dutiable at one-fourth cent per pound.

Sulphide of soda—Summary table.

Year.	Domestic production (calendar year).	Imports for consumption (fiscal year).	Ratio of imports to production.	Value (imports for consumption.	Amount of duty.	Value per pound.	Equivalent ad valorem rate.
	Short tons.	*Short tons.*	*Per cent.*				*Per cent.*
1909	7,673.	267	3.48	.....	.....	.....	.....
1911	.....	228	.....	.....	.....	.....	.....
1912	.....	361	.....	.....	.....	.....	.....
1913	.....	476	.....	.....	.....	.....	.....
1914[1]	20,263	1,265	6.24	$32,830	$5,682	$0.014	17.31
1915	.....	631	.....	18,228	3,158	.014	17.33
1916	.....	40	.35	4,616	201	.057	4.36
1917	49,494	172	.....	7,214	862	.021	11.94
1918	43,490	59	.....	1,707	294	.015	17.21
1919	45,448	157	.....	10,494	787	.033	7.50

[1] From Oct. 4, 1913, to June 30, 1914, at one-fourth cent per pound. For previous years, see p. —.

GENERAL INFORMATION.

Description.—Sulphide soda is mentioned in paragraph 67 of the act of 1913; it is dutiable at one-fourth cent per pound.

It is a chemical compound and when pure, contains about 59 per cent of sodium and 41 per cent of sulphur. There are two commercial forms of sulphide of soda, the "crystal" sulphide and the "concentrated" or "fused" sulphide of soda.

Sulphide of soda crystallizes with nine molecules of water, and it is this product that is known commercially as crystal sulphide of soda. The commercial crystals, which are yellow in color, contain about 30 per cent of pure sulphide of soda. Crystals of pure sulphide of soda are white.

The concentrated or fused sodium sulphide contains about 60 per cent of actual sulphide of soda. It is produced by either furnacing the crystal product or by evaporation in open pots of a solution of sodium sulphide until the product contains 60 per cent of sodium sulphide. The fused product thus contains twice as much sodium sulphide as the crystal product, and it therefore does twice the work of the crystals. However it does not usually bring twice the price of the crystal product and, therefore, is a better buy. It can be easily seen that the fused product is more economical to ship than the crystals, and it is this form that is usually imported into this country.

Uses.—Sulphide of soda is used as a depilatory material in leather manufacture; in the manufacture of sulphur dyes, especially sulphur blacks and blues; in the bath for the dyeing of sulphur colors; to a certain extent as an insecticide; and for the denitrating of nitrocellulose silks. This last use is foreign to this country, as practically no artificial silk of this kind is made in the United States; it is, however, highly developed in France and Belgium.

Process of manufacture.—Sodium sulphide may be manufactured from sodium sulphate (salt cake), which is a by-product of the manufacture of hydrochloric acid, or it is obtained as a by-product of the barium chemicals industry. The war has caused the development of a domestic barium chemical industry, which is undoubtedly a large source of sodium sulphide at the present time (1918).

Sodium sulphide is made from sodium sulphate by fusing it with powdered coal. The coal reduces the sodium sulphate to sodium sulphide, which is lixiviated from the crude mass with hot water. The liquor containing the sodium sulphide is allowed to settle and is then run into crystallizing pans. On cooling, crystals of sodium sulphide ($Na_2S—9H_2O$) separate from the solution. If the fused sodium sulphide is desired the liquor containing the sodium sulphide is evaporated in open caustic pots similar to those used in the manufacture of caustic soda. When the liquor reaches a point where it contains 60 per cent of sodium sulphide the heat is withdrawn and the product allowed to settle for a few hours. The molten sodium sulphide is then run out into drums similar to those used in packing caustic soda where it cools and solidifies, or it may be run into open pans and then broken into lumps after it has solidified.

In the manufacture of barium chemicals the raw material barytes (barium sulphate) is fused with coal, thus producing barium sulphide. The crude barium sulphide is then lixiviated with water, giving a solution of barium sulphide. This solution of barium sulphide in many cases, during the manufacture of other barium compounds, is treated with a soda salt giving the desired barium salt, which is usually insoluble and precipitates out leaving a solution of sodium sulphide. Crystal or fused sodium sulphide is made from this solution as described above.

Sulphide of soda—Production in United States.

[From Geological Survey.]

Year.	Quantity.	Value.
	Short tons.	
1917	49,494	$1,905,473
1918	48,490	2,298,304
1919	45,448	2,645,181

Soda, sulphide of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	½ cent per pound	1,446,379	$20,988	$7,232	$0.015	34.46
1908	do	600,759	9,539	3,003	.016	31.48
1909	do	538,679	7,764	2,668	.015	34.37
1910	do	178,676	2,525	893	.014	35.38
1914 [1]	¼ cent per pound	2,273,037	32,880	5,682	.014	17.31
1915	do	1,263,366	18,228	3,158	.014	17.33
1916	do	80,513	4,616	201	.057	4.36
1917	do	344,617	7,214	861	.020	11.94
1918	do	117,532	1,707	293	.014	17.21
1919	do	314,887	10,494	787	.033	7.50

[1] For sulphide of soda imports for consumption under the tariff act of 1909 (1910–1914), see p. —.

Soda, sulphide of—Imports for consumption—Revenue.

[Act of 1909.]

CONTAINING NOT MORE THAN 35 PER CENT OF SULPHIDE OF SODA.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	¼ cent per pound	118,565	$2,811	$444	$0.024	15.82
1911	do	60,448	1,528	226	.025	14.84
1912	do	66,392	2,430	250	.036	10.31
1913	do	34,970	1,108	131	.032	11.84
1914	do	1,961	184	7	.094	4.00
CONCENTRATED OR CONTAINING MORE THAN 35 PER CENT OF SULPHIDE OF SODA.						
1910	¼ cent per pound	299,415	$3,750	$2,245	$0.013	59.88
1911	do	395,596	4,751	2,966	.012	62.45
1912	do	656,188	8,026	4,921	.012	61.32
1913	do	916,693	11,960	6,875	.013	57.48
1914	do	254,913	3,369	1,911	.013	56.75

Sulphide of soda—Prices, wholesale, per pound, New York, spot, by quarters.

[From Oil, Paint, and Drug Reporter.]

60 PER CENT FUSED.

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	2½–2¾	2½–2¾	2¼–2½	2¼–2½	5 –6¼	3–3¼	4–4½	5¼–6	3½–4
April	2½–2¾	2½–2¾	2¼–2½	2¼–2½	4½–5½	3–3¼	5–5¼	5¼–6	3½–4
July	2½–2¾	2½–2¾	2¼–2½	3 –3½	4 –4½	4–4½	6	3 –3½	3½–4
October	2½–2¾	2½–2¾	2¼–2½	3 –3½	3 –3½	4	(1)	.....	3½–4

30 PER CENT CRYSTAL.

	1912	1913	1914	1915	1916	1917	1918
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	1.5–1.8	1.5–1.8	1.5–1.75	1.5 –1.75	2.0–2.5	2.0–2.25	2.0 –2.5
April	1.5–1.8	1.5–1.8	1.5–1.75	1.5 –1.75	2.0–2.25	2.0–2.25	2.75–3.0
July	1.5–1.8	1.5–1.8	1.5–1.75	1.75–2.25	2.0–2.25	2.6–3.0	3.25–3.50
October	1.5–1.8	1.5–1.8	1.5–1.75	2.0 –2.5	2.0–2.25	2.1–3.0	(1)

[1] Nominal.

Sulphide of soda—Rates of duty.

[Not mentioned specifically prior to the act of 1897.]

Act of—		Tariff classification or description.	Rates of duty, specific and ad valorem.
Year.	Par.		
1897	76	Sulphide of soda	¼ cent per pound.
1909	73	Sulphide of soda containing not more than 35 per cent of sulphide of soda.	¼ cent per pound.
		Sulphide of soda, concentrated, or containing more than 35 per cent of sulphide of soda.	¼ cent per pound.
1913	67	Soda, sulphide of	¼ cent per pound.

SULPHITE AND HYPOSULPHITE OF SODA.

[Par. 67, act of 1913: One-fourth cent per pound.]

Sulphrae of soda—Summary table.

Year.	Domestic production.	Imports for consumption.	Ratio of imports to production.	Value (imports for consumption).	Amount of duty.	Value per pound.	Equivalent ad valorem rate.
	Pounds.	*Pounds.*	*Per cent.*				*Per cent.*
1910		251,074		$4,082	$1,020	$0.016	25.00
1911		987,403		14,810	3,702	.015	25.00
1912		354,232		4,860	1,215	.014	25.00
1913		27,152		400	100	.015	25.00
1914 [1]		382,540		5,627	956	.015	17.00
1915		165,594		4,316	414	.026	9.59
1916		435		60	1	.138	1.82
1917	27,414,000	68,224	0.25	1,221	171	.018	13.97
1918	32,724,000	20,206		301	51	.015	5.55
1919	23,692,000	11,400		1,007	29	.088	2.83

[1] From Oct. 4, 1913, to June 30, 1914.

Hyposulphite of soda—Summary table.

Year.	Domestic production (calendar year).	Imports for consumption (fiscal year).	Ratio of imports to production.[1]	Value (imports for consumption).	Amount of duty.	Value per pound.	Equivalent ad valorem rate.
	Pounds.	*Pounds.*	*Per cent.*				*Per cent.*
1910 [2]		44,759		$626	$209	$0.013	33.38
1911		29,537		612	110	.021	18.10
1912		8,535		277	32	.032	11.55
1913		7,299		228	27	.031	12.01
1914 [3]		926,135		128,828	2,318	.139	1.02
1915		1,855,223		268,693	4,638	.145	1.73
1916		5,125		166	12	.032	7.72
1917	53,196,000	1,836		1,193	5	.650	.38
1918	53,736,000	6,960		6,723	17	.966	.26
1919	64,424,000	27,616		6,312	69	.228	10.95

[1] Insignificant.
[2] From Aug. 6, 1909, to June 30, 1910, under the act of 1909.
[3] From Oct. 4, 1914, to June 30, 1914, under the act of 1913.

GENERAL INFORMATION.

INTRODUCTION.

Paragraph 67. "Soda: * * *; hyposulphite of; * * *, and sulphite of, one-fourth cent per pound; * * *."

Hyposulphite of soda is a commercial term incorrectly used to designate the chemical compound thiosulphate of soda ($Na_2S_2O_3$—$5H_2O$). It is commonly called "hypo" and "antichlor." Hypo-

sulphite of soda in chemical terminology originally referred to a chemical compound of the formula $NaHSO_2$, but the formula for latter proven to be $Na_2S_2O_4$ and the name of hyposulphite of soda has been generally changed to hydrosulphite of soda. Since commercial designations usually prevail in tariff nomenclature, hyposulphite of soda undoubtedly refers to the chemical compound thiosulphate of soda. The term thiosulphate of soda will be used in the following pages to avoid confusion.

Sulphite of soda may include three sulphites of soda known technically as normal sulphite of soda, bisulphite or acid sulphite of soda, and metabisulphite of soda. These three compounds are closely related; they have very similar chemical properties and are used more or less interchangeably.

DESCRIPTION AND USES.

Thiosulphate of soda (hyposulphite of soda) is a white transparent crystalline substance containing, when pure, 63.7 per cent of anhydrous sodium thiosulphate and 36.3 per cent of water. It is very soluble in water and is a strong reducing agent. The crystals of thiosulphate of soda lose their water of crystallization on heating to 100° C., and on heating to a higher temperature the thiosulphate decomposes. Aqueous solutions of thiosulphate of soda when treated with an acid liberate sulphur dioxide with the deposition of sulphur.

Thiosulphate of soda is used as a fixer in photography and is usually designated as "hypo" for this purpose. It is used as an "antichlor" in bleaching to destroy the last traces of chlorine bleach, as a reducing agent in the chrome tanning of leather, and in the manufacture of aldehyde green. It is an important chemical reagent in analytical laboratory work, especially in iodine determinations.

Sulphite of soda.—There are three sulphites of soda, the normal sulphite (Na_2SO_3), the bisulphite or acid sulphite ($NaHSO_3$), and the metabisulphite ($Na_2S_2O_5$). All of these compounds are white crystalline salts more or less soluble in water. These crystals lose their water on exposure to the air. They dissolve fairly readily in water, giving an alkaline solution. Sodium bisulphite is a white powder which smells of sulphur dioxide. It is sparingly soluble in water and on heating decomposes with the evolution of sulphur dioxide. Sodium metabisulphite crystallizes in anhydrous crystals which slowly oxidize on exposure to the air.

The sulphites are largely employed in various industries as antiseptics, reducing agents, and sources of sulphur dioxide. Sulphite of soda is used industrially as an "antichlor" for removing the last traces of chlorine in bleaching processes and as a weak bleaching agent for delicate fabrics, such as silk and wool. Both the normal and metabisulphites are used in the preparation of photographic developers to prevent the oxidation of pyrogallol and hydroquinone. Bisulphite of soda is a more energetic antichlor and bleach for silk and wool than the sulphite. It is also used as an antiseptic in steeping grain, preserving food, and a strong solution is used in sterilizing brewer's casks. Bisulphite of calcium and magnesium is formed during the manufacture of "sulphite pulp" for paper manufacture.

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DOMESTIC PRODUCTION.

The production of thiosulphate of soda (hyposulphite) in 1917 was 26,598 short tons, valued at $717,924. This represents the production of three firms located at Philadelphia, Cleveland, and St. Louis, as reported to the Geological Survey. The combined production of sulphite, bisulphite, and metabisulphite of soda in 1917 was 13,707 short tons, valued at $300,668. This production was reported by firms located in Massachusetts and New York.

The production of bisulphite of soda is the starting point for the manufacture of all of the other articles, so their manufacture may well be considered together. The materials necessary for the preparation of the sulphites are an alkali, usually soda ash, and sulphur dioxide, produced generally by burning sulphur. An additional quantity of sulphur is required for the production of thiosulphate of soda, and metallic zinc is needed for the production of hydrosulphite of soda. These materials are all available in this country in large quantities.

Sodium bisulphite is produced by saturating a solution of soda ash with sulphur dioxide. The acid sulphite produced may be separated from the solution, or an additional quantity of soda ash solution is added, thus converting the bisulphite of soda into the normal sulphite of soda. The sulphite with 7 molecules of water is crystallized from the solution on cooling. Carbon dioxide is evolved in this process, and in some cases it is purified, compressed, and sold as a by-product. Sodium sulphite is also produced as a by-product in the manufacture of phenol. If metabisulphite of soda is desired, the solution of soda ash is supersaturated with sulphur dioxide, thus converting the acid sulphite which is first formed into metabisulphite which is obtained in anhydrous crystals on cooling the solution.

Sodium thiosulphate is produced by boiling a solution of sodium sulphite with sulphur. The resulting solution of thiosulphate is evaporated, and the product crystallizes with 5 molecules of water. This is the process generally used in this country. It may also be obtained from the sulphide residues of the Le Blanc soda process which is operated in Europe but which has never been established in the United States. These residues are allowed to oxidize by exposure to the air, and the soluble sodium and calcium thiosulphate produced are then dissolved from the residues. The solution is treated with sodium sulphate (salt cake) to convert the calcium salt into sodium thiosulphate. The solution is then evaporated and the sodium thiosulphate crystallized out on cooling.

IMPORTS.

Thiosulphate of soda.—The imports of thiosulphate of soda increased from about 8,000 pounds to over 900,000 pounds in 1914, and 1,800,000 pounds in 1915. The imports in the following years declined to below prewar imports. The decline during the war may be attributed to the demand for thiosulphate in the filling of gas masks, as it was the first material used for the absorption of chlorine gas. It was later replaced by more efficient materials. This naturally resulted in a large increased demand in England and France and, along with other war conditions, prevented exportation to this country.

Sulphite of soda.—The imports of sulphite of soda have been rather sporadic. They have not been large compared to domestic production. In 1917 imports were less than 1 per cent of domestic production.

PRICES.

Thiosulphate of soda has increased to a price about double the normal prewar price of $1.30 per 100 pounds. The price of thiosulphate of soda in London has shown a much greater increase. During 1918 the price reached a high level of $11.95 per 100 pounds, which was about 10 times the normal prewar price. This much greater increase in the price of thiosulphate in London was undoubtedly due to the large war demand on thiosulphate for combating chlorine gas.

Sulphite of soda has shown practically no increase in price during the war. This may be accounted for by the fact that during the war large quantities of synthetic phenol were produced and large quantities of sodium sulphite were obtained as a by-product of this process.

Production of sodium thiosulphate in United States.

[From United States Geological Survey.]

Year.	Quantity.	Value.
	Short tons.	
1917	26,598	$717,924
1918	26,868	1,051,623
1919	32,212	1,709,223

Production of sodium sulphite in United States.[1]

[From United States Geological Survey.]

Year.	Quantity.	Value.
	Short tons.	
1917	13,707	$300,668
1918	16,362	478,482
1919	11,846	687,750

[1] Includes sodium bisulphite.

Soda, hyposulphite of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	½ cent per pound..	70,792	$1,093	$354	$0.015	32.38
1908	....do....	12,670	448	63	.035	14.15
1909	....do....	11,456	312	57	.027	18.36
1910	....do....	33,484	481	167	.014	34.81
	⅛ cent per pound..	11,275	145	42	.013	29.16
1911	....do....	29,537	612	110	.021	18.10
1912	....do....	8,535	277	32	.032	11.55
1913	....do....	7,299	228	27	.031	12.01
1914	....do....	2,988	97	11	.032	11.56
	½ cent per pound..	[1] 923,147	128,731	2,307	.139	1.79
1915	....do....	1,855,223	268,693	4,638	.144	1.73
1916	....do....	5,125	166	12	.032	7.72
1917	....do....	1,836	1,193	4	.649	.38
1918	....do....	6,960	6,723	17	.965	.26
1919	....do....	27,616	6,312	6,904	.228	10.95

[1] Includes hydrosulphite. See "Chemicals and allied chemicals used in the United States;" Dept. of Commerce, Misc. Series No. 82.

Soda, sulphite of—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1907	25 per cent	24,396	$803	$201	$0.033	25.00
1908	do	116,964	3,259	814	.028	25.00
1909	do	470,847	10,150	2,537	.022	25.00
1910	do	251,074	4,082	1,020	.016	25.00
1911	do	987,403	14,810	3,702	.015	25.00
1912	do	354,232	4,860	1,215	.014	25.00
1913	do	27,152	400	100	.015	25.00
1914	¼ cent per pound	382,540	5,627	956	.015	17.00
1915	do	165,594	4,316	413	.026	9.59
1916	do	435	60	1	.137	1.82
1917	do	68,224	1,221	170	.017	13.97
1918	do	20,206	301	50	.014	5.55
1919	do	11,400	1,007	29	.088	2.83

Hyposulphite of soda—Prices (wholesale) per hundredweight.

[From Oil, Paint, and Drug Reporter.]

BARRELS.

	1912	1913	1914	1915	1916	1917	1918	1919	1920[1]
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
January	1.30–1.60	1.30–1.50	1.30–1.50	1.60–2.00	2.75–3.00	2.00–2.25	1.75–2.25	2.60–3.60	3.20–4.00
April	1.30–1.50	1.30–1.50	1.30–1.50	1.60–2.00	2.25–2.50	1.75–2.00	2.60–3.60	2.60–3.60	3.20–4.00
July	1.30–1.50	1.30–1.50	1.30–1.50	1.60–2.00	2.25–2.50	1.75–2.00	2.60–3.60	3.20–4.00	3.20–4.00
October	1.30–1.50	1.30–1.50	1.60–2.00	1.60–2.00	2.00–2.25	1.75–2.00	2.60–3.60	3.20–4.00	3.75–4.35

[1] Pea crystals.

KEGS.

	1912	1913	1914	1915	1916	1917	1918	1919	1920[1]
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
January	1.50–2.00	1.40–1.60	1.40–1.60	1.75–2.10	2.90–3.10	2.15–2.30	2.00–2.25	3.60–4.40	3.00–3.75
April	1.40–1.60	1.40–1.60	1.40–1.60	1.75–2.10	2.40–2.65	2.00–2.25	2.60–3.60	3.00–3.75	3.00–3.75
July	1.40–1.60	1.40–1.60	1.40–1.60	1.75–2.10	2.40–2.65	2.00–2.25	2.85–3.10	3.00–3.75	3.00–3.75
October	1.40–1.60	1.40–1.60	1.75–2.10	1.75–2.10	2.15–2.30	2.00–2.25	[2]	3.00–3.75	3.25–3.85

[1] Crystals. [2] Not quoted.

Sulphite of soda—Prices, wholesale, per pound.

[From Oil, Paint, and Drug Reporter.]

CRYSTALS.

	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	2¼–2¾	2¼–2¾	2¼–2¼	2½–2⅝	2½–2⅝	.....	.....	.....	2¾–3
April	2¼–2¾	2¼–2¾	2¼–2¾	2⅝–2⅝	[1]	.....	.....	.....	3¼–4
July	2¼–2¾	2¼–2¾	2¼–2¾	2½–2⅝	[1]	.....	.....	3–3½	3¼–4
October	2¼–2¾	2¼–2¾	2¼–2¾	2¼–2¾	[1]	.....	.....	3–3½	3¼–4

DRY POWDERED.

January	5¼–6	5¼–6	5¼–6	5½–5¾	[1]	[1]	5½–6	5¾–6	[1]
April	5¼–6	5¼–6	5¼–6	5½–5¾	[1]	[1]	5½–6	5¾–6	[1]
July	5¼–6	5¼–6	5¼–6	5½–5¾	[1]	[1]	5½–6	[1]	[1]
October	5¼–6	5¼–6	5¼–6	5¼–5¾	[1]	[1]	5½–6	[1]	[1]

[1] Not quoted.

Hyposulphite and sulphite of soda—Comparison of New York and London wholesale prices.[1]

[Per 100 pounds.]

	Hyposulphite of soda.		Sulphite of soda.	
	New York.	London.	New York.	London.
1912.				
January	$1.30–$1.60	$1.19	$2.25 –$2.75	$1.25
April	1.30– 1.50	1.30	2.25 – 2.75	1.30
July	1.30– 1.50	1.30	2.25 – 2.75	1.22
October	1.30– 1.50	1.19	2.25 – 2.75	1.22
1913.				
January	1.30– 1.50	1.19	2.25 – 2.75	1.22
April	1.30– 1.50	1.25	2.25 – 2.75	1.22
July	1.30– 1.50	1.25	2.25 – 2.75	1.22
October	1.30– 1.50	1.19	2.25 – 2.75	1.22
1914.				
January	1.30– 1.50	1.19	2.25 – 2.75	1.22
April	1.30– 1.50	1.22	2.25 – 2.75	1.25
July	1.30– 1.50	1.22	2.25 – 2.75	1.14
October	1.60– 2.00	2.17	2.25 – 2.75	1.52
1915.				
January	1.60– 2.00	2.28	2.50 – 2.62	1.63
April	1.60– 2.00	2.17	2.50 – 2.62	1.47
July	1.60– 2.00	3.58	2.50 – 2.62	1.63
October	1.60– 2.00	3.91	2.25 – 2.75	1.68
1916.				
January	2.75– 3.00	3.91	2.50 – 2.62	1.74
April	2.25– 2.50	3.58	[2]	1.74
July	2.25– 2.50	3.48	[2]	3.48
October	2.00– 2.25	2.82	[2]	2.39
1917.				
January	2.00– 2.25	2.82	[2]	2.39
April	1.75– 2.00	2.82	[2]	2.28
July	1.75– 2.00	4.02	[2]	2.61
October	1.75– 2.00	4.89	[2]	2.39
1918.				
January	1.75– 2.25	8.69	[2]	2.39
April	2.60– 3.60	11.30	[2]	2.82
July	2.60– 3.60	11.95	[2]	2.61
October	2.60– 3.60	9.12	[2]	2.61
1919.				
January	2.60– 3.60	5.97	[2]	2.61
April	2.60– 3.60	3.69	[2]	2.39
July	3.00– 3.75	.....	[3] .03– .03½	.....
October	[4] 3.00– 3.75	.....	[3] .03– .03½	.....
1920.				
January	[4] 3.00– 3.75	4.04	[3] .03½– .04	2.72
April	[4] 3.00– 3.75	5.65	[3] .03½– .04	2.72
July	[4] 3.00– 3.75	6.52	[3] .03½– .04	3.26
October	[4] 3.25– 3.85	.....	[3] .03½– .04	.....

[1] New York prices are spot, from Oil, Paint, and Drug Reporter. London prices are current, f. o. b. works or usual ports, from the Chemical Trade Journal.
[2] Not quoted
[3] Per pound.
[4] Crystals per 100 pounds.

Hyposulphite and sulphite of soda—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	76	Soda, hyposulphite of	¼ cent per pound.
1909	73	.....do	⅛ cent per pound.
1913	67	.....do	¼ cent per pound.
1913	67	Soda, sulphite of	Do.

COURT AND TREASURY DECISIONS.

Prior to specific provision therefor in 1897, hyposulphite of soda was classified as a chemical salt. (G. A. 2887 (T. D. 15706).)

So was sulphite of soda before 1913. (G. A. 3850 (T. D. 18006).)

Hydrosulphite of soda, classified as a chemical compound or salt, was held not dutiable as hyposulphite of soda. (Abstract 42707.)

○

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 27, 28, and 29 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

THE CRUDE BOTANICAL DRUG INDUSTRY
ERGOT
ETHERS AND ESTERS

(Includes all of Paragraph 27 and Paragraph 477 (Free) relating to botanical drugs)

Paragraph 28:
Ergot

Paragraph 29:
Amyl Acetate
Amyl Nitrite
Ethyl Acetate
Ethyl Chloride
Sulphuric Ether

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PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraphs of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and Index," the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of E. E. Stanford, Sidney D. Kirkpatrick, C. R. DeLong, and Dr. Grinnell Jones, of the chemical division of the commission's staff, and of others.

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SUMMARY

THE CRUDE BOTANICAL DRUG INDUSTRY.

SUMMARY.

Definition:

Drugs are organic or inorganic substances that are used as medicines or in the preparation and composition of medicines. The term "drug" as commonly used, however, is an extremely loose one and has been subjected to various interpretations. It formerly was held to refer to any substance used in any chemical process, and was generally inclusive of spices, condiments, and natural dyeing and tanning materials, as well as substances used for the treatment of disease. The federal food and drug act of June 30, 1906, under section 6, provides a more restricted definition:

> The term "drug" as used in this act shall include all medicines and preparations recognized in the United States Pharmacopoeia or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of man or other animals.

This definition was applied by the Court of Customs Appeals in the interpretation of the word "drugs" as used in paragraph 477 of the tariff act of 1913.[1]

The common interpretation of the word to-day includes not only the medicinals outlined under the above definition, but also a wide variety of more or less crude materials of plant origin, such as gums, balsams, essential oils, perfume materials, and various other products which have some medicinal use, but which are chiefly used for manufacturing or technical purposes. The most important medicinals and their principal nonproprietary combinations are legally standardized as to identity, strength, and purity by the United States Pharmacopoeia and the National Formulary.

Classification:

For the purposes of this publication all drugs may be divided into six classes, the boundary lines of which, however, are not clearly defined.

These classes and their corresponding provisions in the tariff act of 1913 are as follows (paragraphs referred to are given in the Appendix, see page 62):

[1] U. S. v. Maine Central R. R. Co., et al., 7 Ct. Cust. Appls., 114, 117.

1. The natural and uncompounded drugs, chiefly of vegetable origin, such as the balsams, barks, beans, berries, gums, roots, leaves, seeds, and fruits of numerous plants. These drugs in either a crude or advanced state are enumerated by nature or origin in the provisions of paragraphs 9, 27, and 477. Other articles of this class are given specific mention in the following paragraphs: 28, 36, 39, 40, 233, 235, 388, 402, 409, 410, 437, 454, 473, 516, 519, 541, 544, 558, 592, and 595.
2. Alkaloids, glucosides, and other medicinal principles, usually of a definite chemical character, and derived by manufacturing processes from materials within the scope of Class 1, above. (Pars. 5, 13, 18, 31, 47, 70, 584, 591, 594, and 616.)
3. Miscellaneous natural or manufactured substances, such as certain expressed and essential oils, usually of definite origin and character, but not chemical individuals. (Pars. 43, 44, 45, 46, 442, 543, and 561.)
4. Compounded medicinals and pharmaceutical preparations, consisting of mixtures, extracts, tinctures, pills, etc., and including the majority of proprietary medicinals, both alcoholic and nonalcoholic. (Pars. 5, 16, 17, and 249.)
5. Antitoxins, serums, vaccines, and other so-called biological products, chiefly of animal or bacterial origin. (Par. 400.)
6. Organic and inorganic chemical compounds used in medicine, such as alcohol, chloroform, ether, Epsom salts, and Glauber salts, corrosive sublimate, etc., and the coal-tar and other complex chemical medicinals (sometimes termed "synthetics"). Many of these have predominant use in the chemical and technical industries. (Pars. 1, 8, 14, 15, 18, 19, 29, 35, 38, 42, 65, 67, 144, 421, 515, 548, 585, 617, and 635.) Medicinals of coal-tar origin are provided for in Group III of Section 500 of Title V of the act of September 8, 1916.

The present discussion is concerned primarily with vegetable drugs and especially with those in the crude state as produced by cultivation or collected from wild plants. (Class 1 above.) Such medicinals include many of the most important items of the modern materia medica; as examples of primary importance there may be cited crude opium, cinchona, nux vomica, belladonna, digitalis, and senna. Articles of this type, unground and untreated except for the "curing" by drying or otherwise which may be necessary for the proper packing and prevention of decay or deterioration pending shipment and manufacture, are known as crude botanical drugs. These must usually be further treated or compounded with other materials before being used in medicine.

World Trade in Crude Botanical Drugs.

Trade in crude drugs is as ancient as commerce. The superstitious materia medica of the past reached out into unknown corners of the earth for unknown products which derived their chief value from the mystery of their origin. The search for drugs and spices was not the least of the spurs that led to the discovery of the New World. Thousands of plant species have had more or less medicinal vogue. Even now when scientific tests have discarded hosts of valueless medicinals, there is hardly a country which does not furnish some commercial medicinal supply. In former times the drug trade of the world was centered in Hamburg, Germany, and this port largely controlled the commerce in Northern Europe and Asia. Trieste was an

important port for the drug trade of Southern Europe and Northern Africa, and India served as a center for Oriental medicinals. London and Marseilles are centers for their respective countries, and London has now taken, in large part, the former preeminence of Hamburg. New York is the one great port for American domestic, import and export trade, and if its importance attained in the recent war continues, it appears probable that New York will eventually overshadow in importance all foreign ports.

Production of Drugs in Foreign Countries.

In general, it may be said that crude-drug production, from a commercial or agricultural viewpoint, is a relatively unimportant industry. The principal exceptions are the cultivation of opium and cinchona. Drug cultivation has been carried on more or less extensively in Germany and Austria, and to some extent in Italy and Spain. In each of these countries and also in Southern Russia large quantities of drugs are annually collected from wild plants. The majority of European botanicals are gathered thus by the cheapest of peasant labor—old men, women, and children. During the war renewed interest in drug cultivation was manifested in the allied countries. An especially notable feature was the rapid growth of the industry in Japan. There it has been fostered by very favorable climatic conditions, by cheap skilled agricultural labor, and, to some extent at least, by governmental aid. The newly founded Japanese chemical industries have also become prominent in the manufacture of a number of plant alkaloids and extracts. Present reports indicate that Japan in the future will be an important source of botanical drugs.

Domestic Drug Production Under War Conditions.

Experimental cultivation of a number of crude drugs has been carried on for a number of years by the United States Department of Agriculture, colleges of pharmacy, agricultural experiment stations, and by a few drug firms. Upon the outbreak of the war and the partial or complete cutting off of imported supplies, the prices of crude drugs rose to unprecedented heights. Army demands accelerated the upward trend. The influenza epidemic in the United States and abroad called for enormous quantities of drugs. Drug cultivation attracted considerable popular interest, and efforts were made at once to cultivate several indispensable drugs which appeared suited to American climatic conditions. Considerable success has been reported with two important medicinals, belladonna and digitalis, and also with cannabis indica, the drug obtained from Indian hemp. Henbane, stramonium, valerian, and Levant wormseed, all important drugs, have been cultivated with varying success, and the cultivation of others has been undertaken on an experimental scale. Stimulation in the collection of wild drugs, for reasons which will be noted later, was less successful.

Present Status and Probable Future of American Drug Cultivation.

Climatic, labor, and other conditions will doubtless preclude the cultivation in the United States of many large staples, such as opium, coca leaves, cinchona, and nux vomica. There was an overproduction of some of the drugs cultivated during the war and in many cases this resulted in low prices and consequent loss to the growers. Cultivation and preparation of botanical drugs requires a high degree of specialized agricultural and technical skill and experience, valuable land, some special appliances, and a class of labor which is much more expensive in this country than abroad. The scope of the industry is further limited by the exacting climate and soil requirements of most of these crops, by liability to insect and disease damage, and by a comparatively small demand, which in most cases is limited by necessity and can not be stimulated as can the demand for foodstuffs or manufactured products. The possible renewal of low-priced imported supplies has been a constant menace to the domestic industry. American-grown drugs, in general, are more carefully produced, better standardized, and of higher commercial value than were the prewar imports.

The cultivation of these crops in the United States is not likely to be successful except in the hands of specialists having adequate equipment for the proper curing of the crop and possessing special knowledge of the botanical and chemical characteristics of the drug plants. In many cases the quality of the product must be controlled by chemical analyses or animal experimentation. These exacting requirements have been met in the case of certain indispensable drugs, and because of the high prices and absence of foreign competition during the war, their cultivation has been commercially successful. The growers maintain, however, that this cultivation can not be continued after competition with foreign wild products is resumed.

Consumption of Crude Botanical Drugs.

Many articles which are important in medicine have large or predominant use in other connections; for example, licorice is largely used for flavoring plug tobacco, and camphor in the manufacture of celluloid. Considerable quantities of certain drugs, such as santonin, are used in veterinary medicines or stock feeds. The chief channel of consumption of the crude botanical drugs, however, is in the preparation of medicines for the treatment of human disease.

Many important drugs, such as opium, coca leaves, cinchona, nux vomica, belladonna, ipecac, and henbane, owe their therapeutic value to contained alkaloids. The purification of these alkaloids forms an important branch of the drug industry, in which Germany before the war had shown some preeminence. The United States, England,

France, Holland, Java, Switzerland, and Japan also have well-developed alkaloid industries. Large-scale domestic production is limited to the cinchona and opium alkaloids, and to cocaine, strychnine, caffeine, emetine, and hydrastine.

Two general channels of consumption of drug products for human medicinal use may be indicated, although in some instances there is no clear line of demarcation: (1) Prescriptive medicine, in which drugs are prescribed and used under the supervision of a physician. (2) So-called "patent" or proprietary medicine largely used for self-medication. The composition, especially the percentage content of patent medicines, is rarely made known except when required by law. Exceptions may be cited in the class known as "ethical proprietaries," whose formulæ are made known to physicians, to whom they are chiefly advertised. The use of proprietary mixtures containing narcotics, whether so labeled or not, has been proved to result in numerous cases of drug addiction. Constant supervision is also needed to guard against intoxicants masquerading as proprietary medicinals.

In spite of restrictive legislation, the manufacture of proprietaries shows a constant growth. In 1914, 2,903 establishments, with a product value of $102,463,374, were listed by the Bureau of the Census as manufacturers of proprietaries. This represented an increase in product value of 22.3 per cent since 1909 and of 214.1 per cent over that of 1889. The value of patent medicines, compounds, and subsidiary products accounted for about three-fifths of the entire value of products reported by the industries engaged in manufacture of medicines, druggists' preparations, and perfumery and cosmetics. Of the above product value, $83,455,264, or 83.5 per cent, represents strictly medicinal articles, the remainder representing fire-extinguisher compounds, insecticides, etc. The value of druggists' preparations, which includes material for prescriptive medicine, is given at $49,375,739 for 1914. While comparative statistics are lacking, it may be safely assumed that America now leads the world in manufactured medicines.

Although no cost data have been gathered by this Commission, it may be said that the cost of crude drugs, ranging widely as it does from a few cents to less than one one-hundredth cent per medicinal dose, is usually immaterial as compared with the cost of solvents (especially alcohol), labor, manufacturing processes, advertising, and other overhead expenses. The actual cost of an available crude drug has comparatively little effect on its use in legitimate medicine, which is, therefore, unlikely to be affected by a rate of duty at all comparable with those of the past. The choice and amount of drugs used in secret and proprietary medicines, on the other hand, is more apt to be determined by comparative cost. Many drugs, notably

those of the "bitter," "tonic," and "blood purifier" types have been largely used in the past in the manufacture of proprietary compounds of the "pure vegetable product" type, whose actual effect depended in many cases on alcohol and advertising. The sale of such nostrums has been considerably curtailed by the food and drugs act with the Sherley amendment, the Harrison narcotic law as amended, the Volstead Prohibition Act, and various postal laws.

Tariff Treatment and Policy.

In past tariff acts it has been the general policy of Congress to maintain differentials between crude drugs, ground or advanced drugs, and purified or manufactured medicinals, such as alkaloids and compounded medicines.

Grinding is usually the first step in the preparation of medicinals and in the United States drug grinding is practiced both by firms which carry on no further manufacture and by manufacturers of alkaloids and medicinal preparations. While the tariff differential was presumably established for the benefit of the domestic drug-grinding industry, its additional effect in hindering imports of products liable to sophistication should not be overlooked. Adulteration in ground drugs is very difficult to detect and this as well as the tariff differential has tended to develop a preference in the trade for the crude and unground product. The present differential of 10 per cent ad valorem is practically prohibitive of the entry of expensive ground drugs but would hardly be calculated to keep out cheaper materials.

It is not always easy to differentiate between the crude and the advanced product. Paragraph 477 of the free list provides for "natural and uncompounded drugs in a crude state, not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process or treatment beyond that essential to the proper packing of the drugs and the prevention of decay or deterioration pending manufacture." This does not necessarily require the drug to be in its crudest state of occurrence and the initial process or manipulation to obtain the material by itself in the form of an article of commerce does not constitute an advance in value or condition. For example, the Court of Customs Appeals has held that gum resin reclaimed from turpentine, dirt, leaves, and insects had not been advanced in value or condition. (U. S. *v.* Sheldon, 2 Ct. Cust. Appls., 485, 490, and 492.)

The differential between the crude and ground products is not maintained in the case of drugs which are specifically mentioned either on the dutiable list (Schedule A) or on the free list. Specific enumeration permits entry of the crude and advanced drugs at the same rate. Thus the provisions for aconite, ipecac, balm of Gilead,

cocculus indicus, jalap, manna, nux vomica, salep, buchu leaves, cardamom seeds, etc., include the articles in any form or condition under the respective names. Nearly all of the drugs specifically mentioned in the free list of the act of 1913, if not so enumerated, would presumably be classified as crude articles under paragraph 477, or as advanced articles under paragraph 27, or as alkaloids or medicinal compounds under paragraph 5. If the scheme of statistical tabulation recently worked out by a committee representing the executive departments concerned should be adopted, the collection of import statistics will no longer be conditioned upon specific mention in the tariff law. Among the articles the specific mention of which might then be discontinued are: aconite, asafetida, cinchona bark, dandelion roots, ipecac, jalep, and nux vomica.

The mention of certain drugs appears to be traditional only; they are to-day of little or no medicinal or commercial importance and might well be omitted. No imports of balm of Gilead and salep have been reported in recent years. Burgundy pitch, cocculus indicus, dandelion and marshmallow roots are also quite unimportant. As in the case of the articles mentioned in the preceding paragraph, such omission, under a law otherwise similar to the present one, would probably not alter the actual revenue status of future imports should any be received.

For tariff consideration crude botanical drugs may be divided into three classes:

(1) Exotic drugs not commercially produced in the United States.

(2) Exotic drugs whose production in this country has been carried on under war conditions.

(3) Indigenous drugs, not produced to any important extent elsewhere than in the United States.

The last class presents no tariff problems since there are no imports.

In the act of 1913 several largely imported and valuable exotic drugs were singled out for specific tax. As these have not been commercially producible in the United States, except at high cost, the raising of revenue may be presumed to be the sole reason. The duty on these articles ranges from one-fourth cent (on gentian) to 10 cents per pound (on buchu leaves and ergot).

The annual revenue from an individual drug varies from a few dollars to over a million dollars. (Revenue collected on crude opium in 1915 was $1,059,018. See Table 2 on p. 21.) Import statistics indicate that the rate of duty has been without influence on the volume of imports, and a consideration of the actual imposition per medicinal dose indicates no serious burden on individual consumers. The prices of different commodities vary greatly, but $4 per pound

may be taken as a limit which is rarely passed by a crude drug. A pound represents from 250 to 7,000 medicinal doses.

In the case of drugs largely used for the manufacture of alkaloids, a rate sufficient to preserve the approximate equivalence between the crude article and its equivalent in alkaloid, if deemed advisable, could be worked out separately for each article. A duty based on the cost of manufacture would, however, have to be determined by separate inquiry since these costs vary considerably for the different products.

Competition was rarely evident between American medicinals and those produced abroad and heretofore the American crude botanical drug industry appears not to have been considered in tariff legislation. Exotic botanical medicinals were not commercially cultivated in America, either because of unsuitable climate or because American agriculture could not compete with wild or even cultivated materials collected or produced elsewhere by the cheapest classes of labor—old men, women, and children in Europe and coolie labor or its equivalent in Asia and Africa.

In the case of exotic drugs cultivated in the United States, in general, the expense of their production under American conditions so much exceeds their former import prices as to render it very doubtful if their commercial cultivation can persist after normal trade is resumed. While their aggregate value is relatively small, their importance to the public health can hardly be overestimated. Although among the highest priced drugs, their actual cost per dose is insignificant and has comparatively little effect on the prices of the finished medicinals which contain their active principles. They can not be replaced by synthetic medicinals nor can their production be immediately stimulated and secured in emergency as is the case with most of the manufactured products. These products have received little or no attention in previous tariff revisions, but the advisability of their continued cultivation in the United States deserves serious consideration.

GENERAL INFORMATION AND STATISTICS OF INDIVIDUAL DRUGS

GENERAL INFORMATION AND STATISTICS OF INDIVIDUAL DRUGS.

Inasmuch as the factors of production, nature, and use of the individual drugs vary widely, a brief account of the more important articles, and also certain unimportant ones now mentioned in the tariff, is given in the following pages. For the purpose of this presentation, vegetable drugs are divided into three classes, according to their geographic origin and production. These classes are as follows:

(1) Exotic drugs not commercially cultivated in the United States.
(2) Exotic drugs produced by cultivation in the United States.
(3) Indigenous drugs.

I. EXOTIC DRUGS NOT COMMERCIALLY CULTIVATED IN THE UNITED STATES.

SCHEDULE A.

OPIUM.

Production and Trade.

Opium consists of the dried juice of the opium poppy. It is the source of morphine, codeine, heroin, and several other alkaloids. Opium containing less than 9 per cent of morphine has been chiefly used in the preparation of smoking opium; that containing more than 9 per cent is known as medicinal opium. The former was until recent years produced in enormous quantities in India and China, but the traffic is now rigidly restricted in India and supposedly suppressed in China, although governmental vicissitudes have from time to time allowed some recrudescence of cultivation in certain Provinces. The importation of smoking opium into the United States was prohibited in 1909. Asiatic Turkey is the chief source of medicinal opium, which is also produced to a lesser extent in Persia. Persia was the chief source of opium during Turkey's participation in the World War. In Turkey and Persia, opium is produced under exceptionally favorable climatic conditions by cheap but skilled labor. Opium has been produced in many other countries, and experimentally within a wide range throughout the United States, although costs of production here have been found prohibitive. The habit-forming nature of the drug has further served to discourage its cultivation within our borders.

Uses.

Opium is chiefly used for the manufacture of alkaloids, the most important of which are morphine, codeine, and heroin or diacetylmorphine. It owes its therapeutic value chiefly to its content of morphine. Opium and its alkaloids are legitimately used to induce sleep and insensibility to pain, but their continued use entails a serious addiction which often leads to the moral, mental, and physical breakdown of the victim.

Opium Addiction.

As to the prevalence of addiction within the United States, reference may be made to the report of a special committee appointed by the Secretary of the Treasury in 1918,[1] which revealed that the United States consumes from 13 to 72 times as much opium per capita as any other country in which records are available, or about 36 grains (36 medicinal doses) per capita per year. Of 4,092 manufacturers making patent and proprietary medicines and druggists' preparations in 1914, 1,098 reported the use of narcotic drugs, chiefly opium derivatives. Their annual total was, roughly, 352,000 pounds of opium or its equivalent, or nearly 75 per cent of an annual import of 477,000 pounds. It was estimated that about 18,300,000 recorded narcotic prescriptions are filled annually, besides numerous sales of narcotic preparations which were exempt from record under the provisions of the Harrison Act as originally enacted. The number of addicts in the United States is estimated at between 1,000,000 and 2,000,000. The chief cause of addiction is claimed to be medication, as opiates produce in most cases no exhilarent effects comparable to that of alcohol.

Future of the United States Opium Trade.

The future of the opium trade in the United States will be conditioned on the rigid enforcement of regulatory laws. Opium addiction is known to be increasing, and predictions of further increase as a result of alcohol prohibition have been made. The unavoidable use of opium in Army surgery has probably tended to increase the number of addictions, and numerous reports were made of deliberate addiction for the purpose of escaping Army service.

Imports and Prices.

In order to supply the Army needs during the war, legitimate trade in opium was closely controlled by the various Governments. Consumption in the United States was cut because of the reduced supplies, and, presumably, because of the application of the Harrison narcotic law. War conditions and the loss of the Turkish supply

[1] Traffic in Narcotic Drugs. Report of a special committee of investigation appointed Mar. 25, 1918, by the Secretary of the Treasury, Washington, June, 1918.

occasioned a rise in price of crude opium from $6.90 per pound in 1914, to $35 in 1917. High levels were maintained till the spring of 1919, when large shipments of Turkish opium broke the price sharply to near the prewar figure.

Imports of crude opium decreased under war conditions, and those of advanced opium showed a marked increase, owing, doubtless, to its greater economy in shipping space and the great demand which rendered the higher rate of duty a negligible factor in the market. The general imports of crude opium by countries are shown in Table 1 and the imports for consumption in Table 2. Imports of morphine and the other alkaloids of opium are presented in Table 3.

Revenue.

Opium is by far the largest revenue producer of any drug. For the years 1909–1916, crude opium yielded an average annual revenue of $671,968, and the dried grade (1910–1918) of $178,094.

TABLE 1.—*General imports of crude opium, by countries, 1909–1918.*

Imported from—	1909		1910		1911	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
England [1]	217,315	872,129	48,409	191,144	110,589	411,935
Greece						
Turkey in Asia	173,533	616,098	135,957	488,096	239,568	832,277
Turkey in Europe	98,304	373,416	222,950	790,139	225,598	774,642
Portugal						
Italy	750	2,290	3,185	10,100		
France	58	173	32	71		
Persia						
Cuba	5	10				
Germany	21,624	64,473	38,706	142,926	54,087	189,591
All other	5,799	22,929				
Total	517,388	1,951,518	449,239	1,622,475	629,842	2,208,445

Imported from—	1912		1913		1914	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
England	82,782	651,567	61,782	356,971	39,372	161,736
Greece						
Turkey in Asia	132,626	762,745	210,992	1,090,880	222,975	885,517
Turkey in Europe	141,886	797,646	209,413	964,484	160,514	614,838
Portugal						
Italy						
France						
Persia						
Cuba						
Germany	42,343	225,445	26,245	153,630	32,339	148,338
All other						
Total	399,837	2,437,403	508,433	2,565,965	455,200	1,810,429

[1] Shipments from England, Germany and Italy, are reexportations, since these countries are not producers of crude opium.

TABLE 1.—*General imports of crude opium, by countries, 1909–1918*—Continued.

Imported from—	1915		1916		1917	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
England	38,258	234,828	62,665	410,882	65,356	622,363
Greece	2,940	13,460	46,367	274,576	6,138	55,631
Turkey in Asia	212,367	976,234	14,239	54,928	.....	.....
Turkey in Europe	228,162	1,208,767	13,644	64,380	599	4,786
Portugal	.....	.....	4,500	34,166	.....	.....
Italy	2,268	11,631	2,291	18,076	4,285	123,472
France	.....	.....	1,711	15,811	.....	.....
Persia	.....	.....	1,216	6,555	10,257	35,684
Cuba	.....	.....	25	325	.....	.....
Germany	32	85	.....	.....	.....	.....
Canada	.....	.....	.....	.....	177	1,820
All other	.....	.....	.....	.....	.....	.....
Total	484,027	2,445,005	146,658	879,699	86,812	843,418

Imported from—	1918	
	Pounds.	Dollars.
England	126,173	1,951,732
Greece	27,087	422,658
Turkey in Asia	.....	.....
Turkey in Europe	.....	.....
Portugal	.....	.....
Italy	815	42,470
France	1	16
Persia	3,758	26,352
Cuba	.....	.....
Germany	.....	.....
All other	.....	.....
Total	157,834	2,443,228

TABLE 2.—*Imports of opium for consumption in the United States, 1909–1919.*

A.—CRUDE OR UNMANUFACTURED AND NOT ADULTERATED, CONTAINING 9 PER CENT OR OVER OF MORPHIA.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	$1 per pound	465,776	$1,831,679	$465,776	$3.93	25.43
1910 [1]	do	44,195	146,932	44,195	3.32	30.08
1910 [2]	$1.50 per pound	367,249	1,306,240	550,873	3.56	42.17
1911	do	502,407	1,644,301	753,610	3.27	45.83
1912	do	384,911	2,020,026	577,367	5.25	28.58
1913	do	441,276	2,130,154	661,914	4.83	31.07
1914 [3]	do	276,985	1,087,236	415,477	3.93	38.21
1914 [4]	$3 per pound	164,636	644,353	493,908	3.91	76.65
1915	do	353,006	1,699,217	1,059,018	4.81	62.32
1916	do	117,870	535,183	353,610	4.54	66.07
1917	do	43,016	330,652	129,048	7.68	39.03
1918	do	21,342	265,283	64,026	12.43	24.13
1919	do	74,264	977,596	222,792	13.16	22.79

[1] Act of 1897—July 1 to Aug. 5, 1909.
[2] Act of 1909—Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 2.—*Imports of opium for consumption in the United States, 1909–1919*—Contd.

B.—DRIED, POWDERED, OR OTHERWISE ADVANCED, CONTAINING 9 PER CENT AND OVER OF MORPHIA.

1910	$2 per pound	27,934	$128,000	$55,869	$4.58	43.65
1911	do	67,962	304,200	135,925	4.48	44.68
1912	do	77,551	641,887	155,102	8.28	24.16
1913	do	49,070	389,864	98,141	7.94	25.17
1914 [3]	do	4,321	28,061	8,643	6.49	30.80
1914 [4]	$4 per pound	27,773	177,623	111,094	6.40	62.54
1915	do	38,977	308,928	155,908	7.92	50.47
1916	do	44,052	243,790	176,208	5.53	72.28
1917	do	77,990	640,563	311,960	8.21	48.70
1918	do	98,498	1,514,127	393,992	15.37	26.02
1919	do	101,989	1,776,787	407,956	17.42	22.96

[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 3.—*Imports of alkaloids of opium for consumption in the United States, 1909–1919.*

A.—MORPHIA OR MORPHINE, SULPHATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Ounces.				*Per cent.*
1909	$1 per ounce	152	$392	$152	$2.57	38.88
1910 [1]	do	32	66	32	2.06	48.45
1910 [2]	$1.50 per ounce	13,050	60,071	19,575	4.60	32.59
1911	do	20,345	95,067	30,517	4.67	32.10
1912	do	13,825	78,891	20,737	5.71	26.29
1913	do	24,797	141,221	37,195	5.70	26.34
1914 [3]	do	4,235	9,822	6,352	2.32	64.68
1914 [4]	$3 per ounce	1,570	4,398	4,710	2.80	107.10
1915	do	1,383	3,300	4,149	2.38	125.73
1916	do	2,685	8,906	8,055	3.31	90.44
1917	do	5,584	22,675	16,752	4.06	73.88
1918	do	25,215	202,263	75,645	8.02	37.40
1919	do	25,370	158,307	76,110	6.24	48.08

B.—ALL OTHER ALKALOIDS OF OPIUM AND SALTS AND ESTERS THEREOF.

1909	$1 per ounce	3,779	$10,106	$3,779	$2.67	37.39
1910 [1]	do	1,100	2,558	1,100	2.33	43.00
1910 [2]	$1.50 per ounce	21,870	63,406	32,805	2.90	51.76
1911	do	480	2,545	720	5.30	28.31
1912	do	634	1,742	951	2.75	54.60
1913	do	9,672	28,587	14,508	2.96	50.75
1914 [3]	do	7,086	39,371	10,629	5.56	27.00
1914 [4]	$3 per ounce	4,507	25,157	13,521	5.58	53.75
1915	do	8,626	49,584	25,878	5.74	52.19
1916	do	2,360	9,981	7,080	4.22	70.93
1917	do	34,179	165,028	102,537	4.82	62.13
1918	do	20,479	126,882	61,437	6.19	48.42
1919	do	56,895	318,361	170,685	5.60	53.61

[1] Act of 1897—July 1 to Aug. 5, 1909.
[2] Act of 1909—Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913, to June 30, 1914.

COCA LEAVES AND COCAINE.

Production and Trade.

Coca leaves are chiefly imported from Peru, where the plant has been cultivated since prehistoric time. Large plantations are being developed in Java. Experimental cultivation is reported from Florida. The plant is very sensitive to frost. It could probably be grown in our tropical possessions, but the grave moral menace of its use renders any such introduction inadvisable.

Uses.

Coca leaves are used almost wholly in the manufacture of the alkaloid, cocaine, which occurs in amounts from 0.5 to 1 per cent. After removal of the cocaine large amounts of coca leaves are used in the manufacture of soft drinks. The use of coca leaves by addicts is hardly known in the United States, but is almost universal in some South American countries.

The habitual use of cocaine is one of our most serious narcotic problems, as the habit is easily established and is more vicious in its effects than any other narcotic. The committee (referred to under Opium, see p. 19) reports that 75 per cent of the cocaine used in the United States is consumed by addicts. The annual import of leaves is equivalent to about 150,000 ounces of cocaine.

The chief legitimate use of cocaine is as a local anaesthetic. Its habit-forming tendencies have stimulated endeavors to produce non-habit-forming synthetic substitutes. Many of these are successful for certain purposes, but as yet have not wholly replaced cocaine—a result very much to be desired. Many of these substitutes were formerly in the control of German firms. During the war, by the provisions of the trading with the enemy act, the principal one, "novocaine," was licensed for manufacture in the United States as "procaine." The use of cocaine is conditioned by legal restrictions similar to those affecting morphine.

Prices.

Coca leaves normally sold for about 25 to 30 cents per pound, but the quotations for 1919 were about double this figure. Cocaine hydrochloride, which sold for about $2.75 per ounce in 1914, was quoted at over $11 during 1918, and this high level of prices continued during 1919 and the first half of 1920.

Imports and Revenue.

Imports of coca leaves are remarkably uniform in quantity for a drug product, and have shown no appreciable variation with a change in the rates of duty. The high duty on the alkaloid, cocaine, however, has largely limited its normal import to a few rare salts not produced here. As a revenue producer coca leaves rank next to opium among the drug products not used for technical purposes. The average revenue for the period 1911 to 1919 was $79,057. Imports of coca leaves and its alkaloids are shown in Tables 4 and 5.

TABLE 4.—*Imports of coca leaves for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	1,100,649	$126,881	.....	$0.115	.....
1910[1]	do	117,134	16,947	.....	.145	.....
1910[2]	5 cents per pound	591,412	81,507	$29,570	.138	36.28
1911	do	1,226,771	234,162	61,338	.191	26.19
1912	do	1,179,540	201,950	58,977	.171	29.20
1913	do	1,175,780	139,035	58,789	.118	42.28
1914[3]	do	202,062	30,204	10,103	.150	33.45
1914[4]	10 cents per pound	509,502	61,180	50,950	.120	83.28
1915	do	1,048,312	98,870	104,831	.090	106.03
1916	do	947,537	106,627	94,753	.113	88.86
1917	do	634,932	90,131	63,493	.142	70.45
1918	do	1,059,484	179,312	105,948	.169	59.09
1919	do	1,023,321	186,477	102,332	.182	54.88

[1] Act of 1897—July 1 to Aug. 5, 1909.
[2] Act of 1909—Aug. 6, 1909 to June 30, 1910.
[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913 to June 30, 1914.

TABLE 5.—*Imports of cocaine, ecgonine, and salts and derivatives for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Ounces.				*Per cent.*
1909	25 per cent	32,272	$48,343	$12,085	$1.50	25.00
1910[1]	do	29,632	38,163	9,540	1.20	25.00
1910[2]	$1.50 per ounce	24,928	42,438	37,392	1.70	88.11
1911	do	4,031	8,366	6,046	2.08	71.94
1912	do	2,004	3,499	3,006	1.75	85.91
1913	do	3,715	4,835	5,573	1.30	115.25
1914[3]	do	3,205	3,995	4,807	1.25	120.34
1914[4]	$2 per ounce	85	106	171	1.25	161.32
1915	do	179	422	358	2.36	84.83
1916	do	4,275	5,887	8,550	1.37	145.23
1917	do	19,388	38,627	38,776	1.99	100.39
1918	do	8,597	35,358	17,194	4.11	48.63
1919	do	19,382	68,584	38,764	3.54	56.52

[1] Act of 1897—July 1 to Aug. 5, 1909.
[2] Act of 1909—Aug. 6, 1909 to June 30, 1910.
[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913 to June 30, 1914.

LICORICE ROOT.

Production and Trade.

Licorice root, in amount the largest of drug imports, is obtained chiefly from Asia Minor, the Levant, and Southern Europe. The licorice plant has been introduced into America, and thrives under our climatic conditions, even on poor land and with little agricultural care. Before the war, however, the cost of harvesting, precluded commercial production of this normally extremely cheap product in America. Some domestic production has been reported but is believed to be on a more or less experimental scale. Licorice is chiefly used for the manufacture of licorice paste, of which over 90 per cent is used for flavoring plug tobacco, the remainder being utilized in pharmaceuticals and confections.

War trade restrictions on licorice root, and the decreasing duty on licorice paste have tended to favor the importation of the more concentrated commodity, although the root is still predominant. The root

contains the equivalent of about 20 per cent of licorice extract. During the war a number of substitutes for licorice are understood to have been developed for use in tobacco manufacture.

Imports and Revenue.

Imports of licorice root in normal times came chiefly from Turkey in Asia and Asiatic and European Russia. War conditions seriously affected this trade. For 1918 only 27,051,021 pounds valued at $1,863,886 were received, whereas for the years 1909–1919 the average annual import was 76,066,186 pounds and the value $1,866,092.

American imports of licorice paste are contributed chiefly by Spain. Much smaller amounts are received from Italy and still less from France. Revenues have, generally speaking, decreased with the diminution in rate of duty. For the years 1909 to 1913 they averaged $22,244; for the years 1914 to 1919, $10,329. Imports of licorice root and extract are given in Tables 6 and 7.

TABLE 6.—*Imports of licorice roots in a crude state for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	97,742,776	$1,628,894		$0.017	
1910	do	82,209,935	1,365,576		.017	
1911	do	126,140,623	2,060,571		.016	
1912	do	74,680,270	1,309,319		.018	
1913	do	105,032,429	1,806,756		.017	
1914 [1]	do	32,377,106	611,907		.019	
1914 [2]	½ cent per pound	54,377,139	914,150	$135,942	.017	14.87
1915	do	82,289,410	1,557,442	205,723	.018	13.21
1916	do	52,784,042	1,792,573	131,960	.033	7.36
1917	do	59,398,644	2,189,441	148,496	.036	6.78
1918	do	27,051,021	1,863,886	67,627	.068	3.63
1919	do	42,644,661	3,426,007	106,612	.080	3.11

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 7.—*Imports of licorice extracts, in paste, rolls, or other forms, for consumption in the United States, 1909–1919.*[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	4½ cents per pound	520,046	$62,907	$23,420	$0.121	37.23
1910 [2]	do	128,562	14,913	5,785	.116	38.80
1910 [3]	2½ cents per pound	714,038	88,356	17,865	.124	20.22
1911	do	835,268	115,531	20,881	.138	18.07
1912	do	934,092	117,114	23,367	.125	19.95
1913	do	796,222	101,823	19,905	.128	19.55
1914 [4]	do	139,357	18,045	3,483	.129	19.31
1914 [5]	1 cent per pound	786,136	101,596	7,861	.129	7.74
1915	do	1,055,046	149,302	10,556	.141	7.07
1916	do	1,702,927	230,129	17,029	.135	7.40
1917	do	1,156,300	253,671	11,563	.219	4.56
1918	do	734,376	229,812	7,348	.312	3.20
1919	do	413,848	213,028	4,139	.514	1.94

[1] Small quantities imported for manufacture in bond and on which duty was remitted have not been included.
[2] Act of 1897—July 1 to Aug. 5, 1909.
[3] Act of 1909—Aug. 6, 1909, to June 30, 1910.
[4] Act of 1909—July 1 to Oct. 3, 1913.
[5] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

Licorice extract was not quoted in the trade journals before 1916. The price in July, 1916, was 48 cents per pound and rose to a dollar in October, 1918. The powdered extract was quoted at 80 cents per pound in April, 1920. Licorice stick has ranged in price from 23 cents per pound in 1915 to 83 cents in 1919. Crude licorice root was quoted at 14 cents to 16 cents per pound in April, 1920.

ERGOT.

Production and Trade.

Ergot is the product of a fungus disease of rye, and occurs sporadically wherever rye is grown, notably in Minnesota and the Dakotas and in Spain and Russia. Ergot has important and legitimate uses especially in obstetric practice, but is also used criminally to produce abortion. On account of its poisonous nature complete removal from the rye is essential. Since the ergot grains are normally two or three times as large as rye grains, practically complete removal is effected by screening. The ergot thus removed is, however, mixed with other refuse matter, and efforts to concentrate it for drug use have not proved commercially profitable in the United States. Commercial supplies come principally from Spain and Russia, where it is hand-picked from the rye screenings. The Spanish production, according to a recent consular report (June 18, 1920) amounted to 87 metric tons in 1919 as compared with only 6 tons in 1918, and 30 tons in 1917. Although mills grinding rye endeavor to remove all of the ergot, the separation is not always perfect, owing to defective machinery, careless operatives, or the presence of broken or unusually small grains of ergot. Manufactured cereal products containing more than one-tenth of 1 per cent of ergot are considered adulterated under the food and drugs act. (U. S. D. A., Service and Regulatory Announcements, Chemistry 11, item 25, Dec. 31, 1914.) All feed products containing injurious amounts of ergot are likewise considered adulterated. (*Loc. cit.* 15, item 149, Dec. 4, 1915.) While attempts at intentional propagation have not been wholly successful, any high rate of duty markedly increasing prices might incite such attempts, causing loss to neighboring rye growers and resulting in the presence of dangerous amounts of ergot in rye flour and feed products. Obviously such results would be detrimental to the interests of the public health.

Imports.

Imports which come principally from Russia and Spain have averaged about 150,000 pounds. They have varied somewhat in amount since ergot is usually dependent on seasonal conditions in the producing countries. Imports for consumption are shown in Table 8.

TABLE 8.—*Imports of ergot for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	135,740	$36,651		$0.270	
1910	do	181,614	52,911		.291	
1911	do	141,334	75,592		.535	
1912	do	207,138	187,500		.905	
1913	do	223,793	208,364		.931	
1914 [1]	do	22,326	16,256		.728	
1914 [2]	10 cents per pound	163,378	86,384	$16,337	.529	18.91
1915	do	141,915	92,459	14,191	.651	15.35
1916	do	123,015	73,896	12,301	.600	16.65
1917	do	165,701	80,647	16,570	.487	20.55
1918	do	140,474	81,267	14,047	.578	17.29
1919	do	116,813	149,890	11,681	1.283	7.79

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

Declared value for imported ergot in 1909 was 27 cents per pound, in 1912, 93 cents, and in 1919, $1.28 per pound. American wholesale prices have also been very irregular and have ranged between 54 cents per pound in June, 1914, and $5 in April, 1920.

GENTIAN.

Gentian, the most important bitter medicinal, is a wild product of the mountainous regions of southern Europe. Neither there nor in America has its commercial cultivation proved successful. Gentian and other bitters are widely used in tonic proprietary medicines, which chiefly owe their tonic effect to the alcohol contained.

Imports.

Gentian is the largest American drug root import save licorice and the largest whose use is solely as a drug. For the years 1909 to 1919 an average annual amount of 1,268,801 pounds with an average value of $75,207 is reported. Gentian has been dutiable at one-fourth cent per pound since October, 1913, and since that time has produced an average annual revenue of $2,300 (see Table 9).

TABLE 9.—*Imports of gentian for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	1,485,389	$62,445		$0.042	
1910	do	1,177,433	42,356		.036	
1911	do	1,537,919	56,902		.037	
1912	do	1,585,612	67,837		.043	
1913	do	1,796,928	88,281		.049	
1914 [1]	do	831,493	40,164		.048	
1914 [2]	¼ cent per pound	1,350,442	68,955	$3,376	.051	4.90
1915	do	1,022,352	55,553	2,555	.054	4.60
1916	do	788,307	63,240	1,970	.080	3.12
1917	do	1,780,044	218,377	4,450	.122	2.04
1918	do	412,590	46,516	1,031	.112	2.22
1919	do	188,402	26,653	471	.141	1.75

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

American wholesale prices from 1912 through 1915 showed little variation, the maximum being 8¾ to 9½ cents per pound in 1915. During 1916 the price rose to 28 cents, but soon declined, and at the end of 1919 was quoted at 13½ to 14 cents.

SARSAPARILLA.

Sarsaparilla is the root of several species of wild vines found in the forests of tropical America. It has been introduced for cultivation in India and Jamaica, but supplies from these colonies rarely reach the United States. It is commonly used in so-called "blood purifiers" of the proprietary type, and does not rank high in therapeutic favor. It may be but is seldom used in the "sarsaparilla" soft drinks. During the war it was replaced to some extent by the underground stem and roots of several indigenous plants, particularly by the so-called "American sarsaparilla," which is the root of a botanically unrelated plant collected in the Southern Appalachians. Mexican internal disturbances and shipping difficulties have greatly increased the price of sarsaparilla.

Imports.

American imports of sarsaparilla have decreased considerably in recent years. The annual average of the period, 1909–1919, was 319,038 pounds, valued at $42,615. Imports of sarsaparilla are shown in Table 10.

TABLE 10.—*Imports of sarsaparilla for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	570,124	$52,937	.....	$0.093	.....
1910	....do	560,858	59,786	.....	.107	.....
1911	....do	379,091	43,849	.....	.116	.....
1912	....do	452,917	51,428	.....	.114	.....
1913	....do	301,308	38,360	.....	.127	.....
1914 [1]	....do	71,228	8,447	.....	.119	.....
1914 [2]	1 cent per pound	153,742	27,837	$1,537	.181	5.52
1915	....do	250,178	36,055	2,501	.144	6.94
1916	....do	291,276	41,489	2,912	.142	7.02
1917	....do	146,047	18,994	1,460	.130	7.69
1918	....do	110,709	31,454	1,107	.284	3.52
1919	....do	221,946	58,126	2,219	.261	3.82

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

Since 1912 prices of Mexican sarsaparilla have ranged from 9–10 cents per pound in April, 1915, to 41–43 cents in April, 1920. Sarsaparilla from Honduras has increased in price from about 30 cents per pound in 1912 to 80 cents in 1920.

BUCHU LEAVES.

Buchu leaves are a product of British South Africa, used in proprietary medicines and in the treatment of certain genito-urinary diseases. No effort to grow buchu leaves in the United States appears to have been made. America, however, is the largest single consumer of buchu leaves, using from one-half to four-fifths of the total output.

Imports.

Buchu is one of the more important crude-drug imports. For the years 1910–1919 an average annual amount of 110,081 pounds, valued at $95,547 was received. Imports of buchu leaves are given in Table 11.

TABLE 11.—*Imports of buchu leaves for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free		$45,559			
1910	do	130,644	48,652		$0.372	
1911	do	106,345	81,658		.768	
1912	do	181,121	160,608		.887	
1913	do	105,310	114,632		1.090	
1914 [1]	do	18,362	20,860		1.136	
1914 [2]	10 cents per pound	107,006	109,492	$10,700	1.023	9.77
1915	do	120,704	115,689	12,070	.959	10.43
1916	do	94,520	85,061	9,452	.900	11.11
1917	do	100,809	85,807	10,080	.851	11.75
1918	do	50,685	42,431	5,068	.837	11.95
1919	do	85,303	90,573	8,530	1.061	9.42

[1] Act of 1909—July 1, to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

Wholesale prices of buchu leaves from 1912 to 1918 showed little variation, averaging about $1.20 per pound. In January, 1919, the price rose to $2.60 to $2.75 and this high level was maintained throughout the year.

BALSAMS.

"Balsam" is a trade term applied to various more or less odoriferous oleoresins. Resins and oleoresins, including those commercially classed as balsams, are exudations of plants, sometimes occurring naturally in cavities in the plant, or obtained by wounding the plant. The balsams are used for medicinal purposes, in perfumery and cosmetics, and for various technical purposes. By chemical authorities the term, "balsam," is restricted to oleoresins containing benzoic or cinnamic acids or their derivatives. Of chief commercial and therapeutic importance are copaiba, tolu, and Peru balsams. The first-named is not, chemically speaking, a balsam. Copaiba and tolu are products of South American trees, and Peru balsam, of a tree occur-

ring in Salvador, Central America. Copaiba is used in certain varnishes, and is a common ingredient of "quack" medicines for the treatment of genito-urinary and venereal disease. Peru balsam is used in plasters and ointments. Tolu balsam is a common ingredient of cough syrups, and is also used in chewing gums and cheap confectionery. Canadian balsam, an oleoresin collected in Quebec and northern Maine, is used in printing inks and in medicinal plasters. Oregon balsam, a similar but much cheaper product from the States of the Pacific Northwest, is much used as a substitute in printing ink.

Imports.

Statistics of imports and revenue for crude copaiba, Peru, tolu, and Canadian balsams are shown in Tables 12–15. Advanced balsams are rarely imported.

TABLE 12.—*Imports of copaiba balsam for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	234,267	$78,095	.....	$0.312	.....
1910	do	208,566	66,279	.....	.318	.....
1911	do	191,154	56,918	.....	.298	.....
1912	do	159,172	50,969	.....	.320	.....
1913	do	206,447	66,361	.....	.321	.....
1914 [1]	do	64,520	20,561	.....	.319	.....
1914 [2]	10 per cent	180,915	50,778	$5,077	.281	10.00
1915	do	273,616	59,921	5,992	.219	10.00
1916	do	204,464	70,868	7,086	.347	10.00
1917	do	308,545	124,122	12,412	.402	10.00
1918	do	378,362	202,847	20,284	.580	10.00
1919	do	300,659	130,967	13,097	.435	10.00

[1] Act of 1909—July 1 to Oct 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 13.—*Imports of Peru balsam for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	25,843	$24,217	.....	$0.936	.....
1910	do	50,363	49,132	.....	.976	.....
1911	do	37,910	47,840	.....	1.262	.....
1912	do	47,862	63,800	.....	1.335	.....
1913	do	48,996	61,702	.....	1.260	.....
1914 [1]	do	19,518	24,870	.....	1.270	.....
1914 [2]	10 per cent	5,508	4,831	$483	.878	10.00
1915	do	27,506	32,735	3,273	1.190	10.00
1916	do	40,657	112,270	11,227	2.761	10.00
1917	do	58,933	175,355	17,535	2.975	10.00
1918	do	44,082	115,025	11,504	2.609	10.00
1919	do	64,879	163,568	16,357	2.521	10.00

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 14.—*Imports of tolu balsam for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	39,668	$5,589		$0.141	
1910	do	46,946	7,178		.152	
1911	do	21,802	3,328		.153	
1912	do	30,970	7,256		.234	
1913	do	57,277	29,552		.516	
1914[1]	do	14,066	8,139		.579	
1914[2]	10 per cent	28,072	10,924	$1,092	.389	10.00
1915	do	39,750	13,993	1,399	.352	10.00
1916	do	63,579	17,233	1,723	.271	10.00
1917	do	62,820	18,255	1,825	.291	10.00
1918	do	49,869	23,996	2,399	.481	10.00
1919	do	58,194	44,603	4,460	.766	10.00

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 15.—*Imports of Canadian fir balsam for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	4,673	$2,375		$0.508	
1910	do	16,645	8,432		.507	
1911	do	15,788	7,128		.451	
1912	do	3,741	1,741		.465	
1913	do	3,691	1,827		.495	
1914[1]	do	80	62		.775	
1914[2]	10 per cent	13,784	12,443	$1,244	.903	10.00
1915	do	18,610	14,636	1,463	.786	10.00
1916	do	7,113	3,934	393	.537	10.00
1917	do	4,176	3,897	389	.933	10.00
1918	do	3,698	1,404	140	.380	10.00
1919	do	2,344	2,140	214	.913	10.00

[1] Act of 1909—July 1 to Oct. 3, 1913.
[2] Act of 1913—Oct. 4, 1913 to June 30, 1914.

Prices.

The prices for copaiba balsam have shown but little variation, averaging about 50 cents per pound. Peru has increased in price from about $1.50 per pound in 1912 to $5.50 during the first part of 1920. Prices of tolu have varied considerably since 1912. It was quoted at $1.65 per pound in October, 1912, but for most of 1915, 1916, and 1917 it averaged only about 40 cents. Since January, 1918, the price has been in the neighborhood of $1.50 per pound. Canadian balsam is usually sold by the gallon, and has ranged in price from $3.75 per gallon in April, 1912, to $16 per gallon in April, 1920. Oregon balsam, prior to 1918, was quoted at 75 cents to $1 per gallon. The price has since increased to about $1.50–$2 per gallon.

FREE LIST.

CINCHONA BARK.

Production and Trade.

Cinchona bark, which is the source of the important alkaloid, quinine, is the bark of several species of the genus *Cinchona*, native to South America, whence the bark was introduced to medicine in the seventeenth century. The forests of South America were the only source of supply until about 1850, when their destruction by wasteful collection seemed imminent and led to commercial attempts at cultivation, chiefly in Bolivia, India, Ceylon, Jamaica, and Java. Cultivation in South America and Jamaica was not economically successful. In India and Java cultivation established before 1860 has continued to the present day. Ceylon led in the world market for a time, but following enormous overproduction in 1887 Ceylonese cinchona culture was almost abandoned. Since that time Dutch interests in Java have virtually monopolized the world's supply. Although important quantities are produced in India under Governmental auspices, little from this source enters the world trade. Javan cinchona culture was established and fostered by the Dutch Government. In former years the bark was wholly exported, chiefly via Amsterdam, but more recently extensive quinine factories have been established in Java. The Java industry, which controls 90 per cent of the world's supply of bark, is under centralized control. The success of the monopoly may be attributed to Governmental aid, favorable climatic and soil conditions, cheap labor, and the development (through cultivation and selection) of varieties yielding bark far richer in alkaloids than the South American wild product. International trade was regulated till the opening of the World War by the International Quinine Cartel, a close association of Dutch, German, and British manufacturers. French and American firms were prevented from formally participating in the agreement because of the antitrust laws of France and the United States. After the opening of the war, the cinchona and quinine situation was virtually under the dictation of the Dutch Government through the Kina Bureau, with headquarters in Amsterdam. This bureau consists of three representatives of the planters, three of the quinine manufacturers, and an outside chairman. The Governments of the various importing countries rigorously controlled the imports, use, and sale of forthcoming supplies of cinchona bark. English firms at one time were reported to have gained extensive holdings in Java, but later reports indicate that these holdings are insufficient, even with increased Indian production, to satisfy the requirements of the British Empire. In 1919 there were 120 Dutch planters and 6 British. The former control ten-elevenths and the latter one-eleventh of the total Javan production. The recent tendency of

the Dutch combine has been to restrict bark exports and to sell the product as crude quinine. The growth of quinine manufacture in Japan has been rapid, but that country also is dependent on Java for bark. Much interest has been manifested in possible renewal of supplies from South America, where the discovery of new forests has been reported. Experimental cultivation in the Philippines has been undertaken, but offers no prospects of commercial importance in the near future. The tree is not hardy in the United States proper. Former German plantations in East Africa are now under British control, but are still on a small scale. The immediate future of quinine production appears therefore under Dutch control.

Uses.

Cinchona bark is used chiefly in the manufacture of its alkaloids, of which quinine is of most importance. The alkaloid content of commercial bark runs from 5 to 8 per cent; the proportion of quinine varies with the variety, being usually from two-thirds to three-fourths of the total alkaloids. Cinchona and its alkaloids are indispensable in the treatment and prevention of malarial fever, and are also used extensively in colds and similar affections. They were in much demand during the influenza epidemic. The crude bark and the alkaloids other than quinine (chiefly cinchonine, cinchonidine, and quinidine) are also used extensively in proprietary medicine.

Prices.

During recent years prices for cinchona bark have ranged from about 20 cents in 1912 to over $1 per pound during 1918. Prices decreased somewhat during 1919 and in April, 1920, the red quills of cinchona bark were quoted at 70 to 80 cents per pound. Quinine sulphate, the most important salt of the principal alkaloid, increased in price from 26 cents per ounce in January, 1915 to 90 cents during 1919 and the first quarter of 1920. Cinchonidine sulphate was quoted at 16 cents per ounce in August, 1914 and has gradually increased until in April, 1920 the price was 88 cents per ounce. Similarly the price of cinchonine sulphate has risen from 7 cents per ounce in August, 1914 to 45 cents in April, 1920.

Imports.

Cinchona bark is one of our largest medicinal imports, averaging (1909–1919) about 3,500,000 pounds, valued at $500,000. Since it is on the free list it yields no revenue. General imports by principal countries are given in Table 16 and imports for consumption are shown in Table 16a. Imports of cinchona alkaloids are given in Table 17.

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TABLE 16.—*Imports by countries of cinchona bark, or other bark from which quinine may be extracted, 1909–1918.*

Imported from—	1909		1910		1911	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Netherlands	3,422,181	254,475	3,052,371	221,572	3,768,935	292,704
United Kingdom	15,531	1,388	41,812	3,399	19,233	1,238
Germany	64,711	7,249	206,300	17,116	37,880	3,692
Total	3,502,423	263,112	3,300,483	242,087	3,826,048	297,634

Imported from—	1912		1913		1914	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Netherlands	2,840,477	228,560	3,493,945	351,520	3,618,968	461,247
United Kingdom	32,733	2,439	29,684	2,689	11,637	1,312
Germany	18,305	2,302	9,610	745	18,043	1,827
All other	308	22	20,000	2,536	220	26
Total	2,891,823	233,323	3,553,239	357,490	3,648,868	464,412

Imported from—	1915		1916		1917	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Netherlands	2,912,242	556,220	3,657,273	726,906	2,329,664	633,679
United Kingdom	8,147	904	283,623	49,817	191,683	50,540
Peru	19,913	3,353	3,874	323	927	124
Germany			933	226		
All other	4,247	629	1,617	365	9,123	1,593
Total	3,944,549	561,106	3,947,320	777,637	2,531,397	685,936

Imported from—	1918	
	Pounds.	Dollars.
Germany		
Netherlands	655,382	178,879
United Kingdom	85,414	34,721
Panama	29,120	10,192
Ecuador	13,852	672
Peru	100,646	34,235
China	191,185	47,856
Dutch East Indies	2,193,561	502,620
All other	4,468	1,600
Total	3,273,628	810,775

TABLE 16a.—*Imports of cinchona bark (or other barks from which quinine may be extracted) for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	3,502,385	$263,112	$0.075
1910	do	3,305,894	255,763	.077
1911	do	4,136,354	341,896	.083
1912	do	2,935,350	239,182	.081
1913	do	3,329,973	354,503	.106
1914	do	3,654,968	464,411	.127
1915	do	3,951,196	561,802	.142
1916	do	3,967,320	777,637	.196
1917	do	2,531,397	685,936	.271
1918	do	3,131,958	779,403	.249
1919	do	3,866,158	803,061	.208

TABLE 17.—*Imports of cinchona alkaloids and salts for consumption in the United States, 1909–1919.*

Year.	Rate of duty.	Cinchonidia.		Quinia, sulphate of.		All other.	
		Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.
1909	Free	60,332	11,590	2,065,765	285,125	204,207	40,357
1910	do	229,243	46,886	2,345,472	318,375	337,481	32,646
1911	do	17,272	4,219	2,469,082	347,241	615,840	58,942
1912	do	136,197	14,183	2,368,840	361,111	539,201	91,802
1913	do	309,395	43,680	2,279,734	397,409	648,865	131,692
1914	do	205,006	19,502	2,224,765	486,641	452,292	117,915
1915	do	69,487	8,223	1,508,931	378,511	208,330	66,004
1916	do	131,481	15,814	1,409,228	1,022,821	231,100	82,167
1917	do	221,272	17,590	623,947	324,438	418,366	143,004
1918	do	86,482	20,708	1,256,172	593,019	104,650	44,369
1919	do	86,000	25,495	2,101,006	1,238,125	1,147,102	272,631

NUX VOMICA.

Nux vomica is the seed of a tropical tree produced in India and Cochin China. It is used in the manufacture of its alkaloids, of which strychnine is of chief importance. Strychnine is a valuable heart remedy, and is also used extensively for poisoning vermin. Large quantities of nux vomica are employed in the manufacture of its alcoholic tincture and of proprietary remedies of the "bitter" and "tonic" class.

Imports.

Imports of nux vomica come chiefly from India. In 1914, British India furnished 93 per cent of the total imports. In amount nux vomica is one of the largest American drug imports; for the years 1909–1919 an average annual amount of 2,881,075 pounds, valued at $87,548, was reported. Imports for consumption are shown in Table 18.

TABLE 18.—*Imports of nux vomica for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	1,666,957	$27,370	$0.016
1910	do	2,738,062	35,170	.013
1911	do	4,330,402	58,183	.013
1912	do	2,427,187	37,782	.016
1913	do	2,306,735	39,380	.017
1914	do	1,891,072	32,983	.017
1915	do	2,245,338	51,507	.022
1916	do	4,355,964	134,366	.030
1917	do	2,445,984	86,018	.035
1918	do	2,739,814	111,711	.040
1919	do	4,543,710	348,559	.077

Prices.

The prewar price for nux vomica averaged about 5 cents per pound for the whole seed and 7 to 8 cents for the powdered. During 1917 prices practically doubled, and although falling off somewhat

during 1919, the whole seeds were quoted at 13 to 14 cents per pound in April, 1920, and the powdered at 18 to 19 cents.

IPECAC.

Ipecac is a root imported from Colombia, Brazil, and Panama. It is a high-priced medicinal, valued in bronchial diseases as an emetic and as the source of the alkaloid, emetine. Both ipecac and emetine are used in diseases caused by amoebae. Ipecac of American commerce is the wild product of the South American forests and attempts to cultivate it in other tropical countries have usually been unsuccessful. However, in India and in the Straits Settlements small scale cultivation is maintained.

Imports.

Imports, which are shown in Table 19, averaged 85,023 pounds, valued at $157,366, for the period 1909–1919.

TABLE 19.—*Imports of ipecac for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	35,166	$27,945	$0.795
1910	do	36,261	29,738	.820
1911	do	27,554	36,522	1.320
1912	do	41,627	59,828	1.440
1913	do	56,648	86,113	1.580
1914	do	78,554	110,316	1.400
1915	do	137,927	248,408	1.801
1916	do	203,734	484,828	2.379
1917	do	84,672	146,505	1.730
1918	do	60,972	122,281	2.005
1919	do	171,944	378,542	2.202

Prices.

Wholesale prices of Cartagena (Colombian) ipecac ranged from $1.45 per pound in 1912 to $4.25 during the first part of 1919. In April, 1920, this variety of ipecac was quoted at $3.25 per pound. The Rio (Brazilian) ipecac has followed about the same range.

ACONITE.

Aconite is a root imported from Southern Europe; a closely related species comes from Japan. The leaves of the same plant, although of less value, are also used to some extent. Aconite is a cardiac sedative and the source of the alkaloid, aconitine, one of the most poisonous substances known. It is an important medicinal, though used only in small quantities.

TABLE 20.—*Imports of aconite for consumption in the United States, 1911–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1911	Free	7,959	$613	$0.077
1912	do	21,385	1,721	.080
1913	do	12,946	1,065	.082
1914	do	4,267	321	.075
1915	do	8,821	962	.109
1916	do	6,720	538	.080
1917	do	34,285	8,724	.254
1918	do	475	119	.250
1919	do	22,320	4,462	.200

Imports.

Imports (see Table 20) are small and variable. Before the war aconite came chiefly from Germany and Austria-Hungary, but during the war supplies have been derived from Japan and Spain. The Japanese product is not identical with the European and is not recognized by the U. S. Pharmacopoeia, IX.

Prices.

Aconite root sold for 13 to 15 cents per pound before the war and the leaves were quoted at 7 to 8 cents. In April, 1916, the price of the former rose to 50–75 cents and this level obtained during 1917, 1918, and 1919. In April, 1920, aconite root was quoted at 75–85 cents per pound.

ASAFETIDA.

Asafetida is an ill-smelling gum-resin from the Asiatic deserts. It is marketed chiefly via England and India and is used in nervous diseases.

Imports.

Imports are quite variable in amount and value; for the years 1909–1919 an average annual amount of 92,011 pounds, valued at $43,934, was reported (see Table 21).

Prices.

Owing to its very variable character prices of asafetida cover a wide range. For the years 1912–1919 the wholesale price has ranged between 35 cents and $4 per pound. Asafetida in lump form was quoted at $3.50 and the powdered asafetida at $4.50 per pound in April, 1920.

TABLE 21.—*Imports of asafetida for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	42,335	$6,143	$0.145
1910	do	95,536	34,574	.362
1911	do	114,066	70,902	.617
1912	do	138,066	77,035	.558
1913	do	134,579	55,868	.415
1914	do	106,338	27,193	.256
1915	do	51,727	12,656	.245
1916	do	115,856	30,126	.260
1917	do	107,486	52,877	.492
1918	do	57,398	44,741	.779
1919	do	48,119	71,261	1.481

MANNA.

Manna is the dried juice of the manna ash which is cultivated in Sicily. It is an important medicinal in the tropical Americas, Porto Rico being the chief American market. It is used as a laxative and as a source of the sugar, mannite. Tagua-nut waste is a more important but recently developed source of this little-used sugar.

Imports.

For the years 1909–1919 an annual import of 63,474 pounds valued at $29,965 was received. In 1914 almost 99 per cent of the imports came from Italy. Imports are shown in Table 22.

TABLE 22.—*Imports of manna for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	69,942	$21,250	$0.304
1910	do	47,658	17,307	.363
1911	do	47,427	21,424	.452
1912	do	96,307	49,335	.512
1913	do	30,869	16,303	.528
1914	do	88,240	32,848	.372
1915	do	36,833	12,276	.333
1916	do	68,447	32,434	.473
1917	do	75,336	48,613	.645
1918	do	93,097	50,032	.537
1919	do	44,063	27,794	.631

Prices.

The price of manna has not varied appreciably since 1912. The large flakes have averaged about 90 cents per pound and the small flakes about 60 cents per pound.

JALAP.

Jalap is the dried root of a plant which is native to Mexico and cultivated both in that country and in India. Jalap is one of the more important cathartic medicinals.

Imports.

Imports come wholly, or virtually so, from Mexico and in recent years have fluctuated largely both in quantity and value. For the years 1909–1919, imports (see Table 23) averaged 169,977 pounds valued at $30,188.

TABLE 23.—*Imports of jalap for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	66,096	$15,096	$0.228
1910	do	199,905	38,080	.190
1911	do	230,679	61,415	.266
1912	do	119,211	27,607	.232
1913	do	277,275	44,632	.161
1914	do	208,901	23,942	.115
1915	do	176,047	18,485	.105
1916	do	201,383	13,642	.067
1917	do	168,639	14,315	.084
1918	do	126,511	34,238	.270
1919	do	95,103	40,667	.428

Prices.

From 1912–1919, prices of jalap have ranged from 8–10 cents per pound in 1915 to 75–80 cents in October, 1919. The price quoted in April, 1920, was 60–75 cents per pound.

DANDELION ROOT.

Dandelion root is an unimportant bitter medicinal which is used in tonics and "blood purifiers," chiefly of proprietary nature. It is collected for commerce more or less extensively in Germany, Switzerland, Austria, and France, from both wild and cultivated plants. The plant has become a pestiferous weed in the United States and is not cultivated here for drug use.

Imports.

For the period of 1909–1919 the average annual imports are 86,292 pounds, valued at $12,013. Imports for consumption are shown in Table 24.

TABLE 24.—*Imports of dandelion root for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	47,884	$3,058	$0.034
1910	do	35,919	2,436	.068
1911	do	72,223	4,717	.065
1912	do	97,942	7,372	.075
1913	do	108,434	8,269	.076
1914	do	109,658	9,389	.086
1915	do	112,814	12,137	.107
1916	do	29,378	6,487	.220
1917	do	108,713	23,912	.219
1918	do	149,068	37,773	.253
1919	do	77,165	16,600	.215

Prices.

Wholesale prices of imported dandelion root have ranged from 9½ cents per pound in 1912 to 40 cents in 1917. Prices in 1919 dropped to about 25 cents. In April, 1920, the foreign product was quoted at 22–23 cents per pound and the domestic at 21–22 cents.

MARSHMALLOW OR ALTHEA ROOTS, LEAVES, AND FLOWERS.

Marshmallow or althea roots, leaves, and flowers are mucilagenous drugs, formerly imported from Germany, but since the war, from Italy, Spain, and France. As medicinal agents they are of negligible importance though occasionally used as demulcents and in poultices. Marshmallow root although no longer used in the manufacture of "marshmallow" confectionery, was the original mucilagenous constituent from which this product received its name. The use of marshmallow root in confectionery has now been largely replaced by such substances as gum arabic.

Imports.

Imports from 1911 to 1916 averaged only about 5,000 pounds, valued at less than $1,000. Since 1917 imports have increased greatly, for 1917–1919 the average annual import was 19,962 pounds, valued at $5,995. (See Table 25.)

TABLE 25.—*Imports of marshmallow or althea for consumption in the United States, 1910–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1910	Free	50	$8	$0.160
1911	do	3,380	301	.089
1913	do	4,270	538	.126
1914	do	6,049	514	.085
1915	do	6,645	1,209	.182
1916	do	7,242	1,936	.267
1917	do	23,120	5,846	.252
1918	do	24,246	6,824	.281
1919	do	12,519	5,316	.425

Prices.

Wholesale prices of the whole althea root have ranged in recent years from 16 cents per pound in 1914 to 50 cents in 1916. The cut root was quoted at 22–25 cents per pound in January, 1914, and increased in price to 80–82 cents in January, 1919. The price of whole althea root in April, 1920, was 25–27 cents per pound.

CARDAMOM SEEDS.

Cardamom seeds are the dried seeds of an Indian plant and are used chiefly as an aid to the action of other drugs in cordials and tonics. India itself is the chief consuming country. The largest exports from South India were in 1914–15 and amounted to 5,850

tons. Of these the United Kingdom took 49 per cent, Ceylon 36 per cent, and Germany 15 per cent.

Imports.

From 1909 to 1919 imports, which come principally from India and East Indies, averaged 144,528 pounds valued at $78,149. (See Table 26.)

Prices.

Cardamom seeds have not shown any great price fluctuation since 1912, ranging usually between 60 cents and $1.25 per pound.

TABLE 26.—*Imports of cardamom seed for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Pounds.		
1909	Free	104,961	$45,612	$0.434
1910	do	126,267	51,740	.410
1911	do	94,398	45,788	.485
1912	do	81,964	47,403	.578
1913	do	113,461	104,287	.919
1914	do	80,782	72,148	.893
1915	do	152,679	106,180	.695
1916	do	225,687	119,162	.528
1917	do	214,464	88,605	.413
1918	do	255,318	108,605	.425
1919	do	139,808	70,114	.502

COCCULUS INDICUS.

Cocculus indicus is a poisonous berry, imported from India and used to a slight extent in ointments for the destruction of skin parasites.

Imports.

Since cocculus indicus is imported most frequently as "fish berries," it is difficult to obtain accurate statistics of importation. Imports classified as cocculus indicus have been very small and of practically no significance.

Prices.

The prewar price of cocculus indicus was about 3 cents to 5 cents per pound. This price doubled during the last quarter of 1917, and steadily increased until in July, 1919, it was quoted at 85 cents to $1 per pound. By April, 1920, however, the price had dropped to 25–30 cents.

SALEP OR SALOP.

Salep or salop is a mucilaginous root which constitutes an important article of food in Asia Minor. It is sometimes prescribed in the diet of invalids, but its use is obsolete in American practice.

Imports.

For the years 1912–1915 a total value of $3,035 is reported for the imports. No import statistics since 1915 are recorded. Neither import value per pound nor domestic wholesale prices are available.

BALM OF GILEAD.

Balm of Gilead is a resinous juice formerly used in medicine and cosmetics, but now obsolete in American commerce. Neither price nor import statistics are available.

DRUGS NOT SPECIALLY PROVIDED FOR IN THE TARIFF ACT BUT FOR WHICH IMPORT STATISTICS ARE AVAILABLE.

SENNA.

Senna leaves are obtained from two closely related shrubs, one occurring wild in Egypt (Alexandria senna) and the other cultivated in India (Tinnevelly senna). It is used as a mild cathartic, and is one of the most important drugs of its class. A pound corresponds to 100–120 medicinal doses.

Production.

Senna is not produced commercially within the territorial limits of the United States, but an attempt to cultivate it in Texas about 1905 has been noted. The crop is dependent on cheap labor and a tropical climate. The chief centers of production are in Northern Africa, Arabia, and India. The senna of the two former countries is the product of wild plants, and is collected in the deserts by the natives. Indian senna, on the other hand, is extensively cultivated, and under war conditions a considerable increase of production took place. Extreme adulteration, caused by higher prices, together with Indian and English export restrictions, greatly upset the market, and a considerable decrease in acreage is said to have resulted.

Imports.

Senna is the largest American drug leaf import, both in quantity and value. For the years 1909–1919 an average annual amount of 2,936,846 pounds, valued at $333,309, is reported. In 1914 Egypt furnished 42.2 per cent of the imports, British India 34.7, England 18.1, and the remainder came from France, Germany, and Italy. Imports are shown in Table 27.

TABLE 27.—*Imports of senna leaves for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	2,159,553	$99,356	$0.046
1910	do	2,564,452	129,229	.050
1911	do	3,063,275	143,846	.047
1912	do	3,164,003	154,012	.049
1913	do	2,634,117	150,554	.057
1914	do	2,454,772	173,054	.070
1915	do	2,180,288	209,313	.096
1916	do	2,794,400	361,881	.129
1917	do	5,161,315	844,733	.166
1918	do	3,575,066	771,067	.216
1919	do	2,554,069	628,852	.246

Prices.

Tinnevelly senna has ranged in price from 6–12 cents per pound in 1912 to a maximum of 27–37 cents in 1916, and at the end of 1919 was quoted at 14–20 cents. Alexandria senna has ranged from 22 cents to $1.20 a pound during this period. In April, 1920, Tinnevelly senna leaves were quoted at 15–20 cents per pound and the whole Alexandria leaves at 85 cents to $1 per pound.

ALOES.

Aloes is the dried juice of a tropical plant and is commonly classed as a gum. Several varieties are known, but the most common is imported from Curaçao, Dutch West Indies. Aloes is a cathartic, and is an ingredient of many proprietary pills. Aloes is produced in the West Indies (Curaçao aloes); in northwestern Africa (Socotrine aloes), and in southern Africa (Cape aloes). No production in the United States is reported.

Imports.

Imports are of crude aloes, and for the years 1909 to 1919 an average annual import of 1,059,299 pounds, valued at $85,351, was received. (See Table 28.)

Prices.

Prices vary greatly for the four different varieties of aloes. True Barbados aloes is the most costly, averaging about $1 to $1.25 per pound. Socotrine aloes formerly sold for about 25 cents per pound, but during 1919 and early 1920 the price has been in the neighborhood of 80–90 cents. Curaçao and Cape aloes both sell for about 10–15 cents per pound.

TABLE 28.—*Imports of aloes for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	671,257	$40,963	$0.060
1910	do	944,007	57,638	.060
1911	do	980,205	71,044	.070
1912	do	666,229	52,753	.079
1913	do	909,279	77,938	.086
1914	do	918,402	64,983	.071
1915	do	953,186	90,081	.095
1916	do	1,597,811	152,146	.095
1917	do	1,236,381	97,607	.079
1918	do	1,230,595	95,846	.077
1919	do	1,544,940	137,857	.089

RHUBARB.

Medicinal rhubarb, which differs botanically from the common garden species, is the underground stem and root of several plants of Chinese origin. Efforts to cultivate medicinal rhubarb outside of China have not been commercially successful. Rhubarb is a laxative and cathartic, being especially valued in ailments of children.

Imports.

Imports of rhubarb root have averaged about 150,000 pounds, valued at approximately $18,000 (1909–1919). Imports are shown in Table 29.

TABLE 29.—*Imports of rhubarb for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	63,715	$7,508	$0.118
1910	do	107,341	16,147	.150
1911	do	125,816	13,950	.112
1912	do	149,838	15,756	.105
1913	do	121,701	16,554	.136
1914	do	181,240	22,354	.123
1915	do	233,699	24,592	.105
1916	do	155,924	17,701	.113
1917	do	238,601	32,084	.134
1918	do	190,972	20,879	.109
1919	do	109,242	46,908	.429

Prices.

For the years 1912 to 1920 prices of the dried rhubarb have ranged from 13½ cents per pound in January, 1916, to $1.80 in October, 1919. The high dried roots in April, 1920, were quoted at $1.20 per pound and the powdered rhubarb at $1.40.

ORRIS ROOT.

Orris root is produced chiefly in Italy and Germany and used in perfumes and dentifrices. An attempt to cultivate orris root generally throughout the United States was made by a private company about 10 to 15 years ago. As an industry, however, it has not developed to any appreciable extent.

Imports.

Orris root is imported almost wholly from Italy. The average imports for the years 1909–1919 were 527,207 pounds, valued at $51,789. (See Table 30.)

TABLE 30.—*Imports of orris root for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	529,054	$27,229	$0.051
1910	do	636,539	44,947	.071
1911	do	555,698	42,223	.076
1912	do	583,303	44,395	.076
1913	do	357,963	37,326	.104
1914	do	580,484	71,941	.124
1915	do	554,125	52,993	.095
1916	do	602,280	62,552	.103
1917	do	527,539	61,494	.116
1918	do	465,960	55,728	.119
1919	do	406,278	68,956	.170

Prices.

The price of the principal grade of orris root (Florentine, whole) has risen from 10 cents to about 30 cents per pound in the period 1912–1919. In April, 1920, the price had decreased to 15–16 cents per pound.

CHAMOMILE FLOWERS.

Chamomile flowers are the dried flowers of several species of plants occurring both wild and cultivated in Germany and elsewhere in Europe. American imports are said to be largely used by German physicians and in proprietary medicines for the diseases of women. This drug has extensive use in Germany and that country utilizes a large portion of her production, besides importing from other European countries. Hamburg is the center of this trade.

Imports.

For the years 1910–1919 an average annual value of $23,822 is reported. Germany and Austria-Hungary were formerly the principal sources of supply, although Belgium, Spain, and Japan have furnished considerable quantities.

Prices.

Several varieties of chamomile flowers are quoted in the New York wholesale drug market. Prices for Roman chamomile flowers have ranged from 15 cents in July, 1914, to $1.50 per pound in October, 1917. Hungarian style chamomile was worth about 10–12 cents before the war and has gradually increased until in April, 1920, it was quoted at 52–54 cents per pound.

TABLE 31.—*Imports of chamomile flowers for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Value.	Fiscal year.	Rate of duty.	Value.
1909	Free	$7,528	1915	Free	$13,313
1910	do	19,617	1916	do	27,510
1911	do	19,110	1917	do	64,432
1912	do	17,227	1918	do	41,586
1913	do	14,176	1919	do	14,994
1914	do	6,252			

COLOMBO ROOT.

Colombo root is a bitter medicinal used for the same purposes as gentian, but it is not an important medicinal. The plant grows wild and is also cultivated in Africa.

Imports.

Imports have been small. For the years 1909–1919 the average annual amount of 21,385 pounds, valued at $1,350, is reported. (See Table 32.)

TABLE 32.—*Imports of colombo for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	3,022	$101	$0.033
1910	do	2,288	94	.041
1911	do	8,436	610	.072
1912	do	16,384	613	.037
1913	do	27,565	794	.029
1914	do	4,587	134	.029
1915	do	8,751	458	.052
1916	do	48,867	3,442	.070
1917	do	92,349	4,999	.054
1918	do	20,759	3,061	.147
1919	do	2,195	548	.250

Prices.

The prewar price of colombo root was about 6–8 cents per pound. This was doubled in 1917, and during 1918 and 1919 the price was further increased to about 25 cents per pound. In April, 1920, it was quoted at 15–16 cents.

OTHER FOREIGN DRUGS.

The most important of these will be mentioned under "Exotic drugs cultivated in the United States," which follows. Others of some importance are quassia, chiretta, myrrh, benzoin, guaiac, calamus, triticum, pareira brava, scammony, areca nuts, strophanthus, styrax, and squills. Import statistics for all other drugs, which are grouped in the general classifications, are shown in Tables 33 to 37.

TABLE 33.—*Imports of all other drugs, such as beans, berries, etc., which are natural and uncompounded drugs, not advanced in value or condition, 1909–1919.*

Year.	Rate of duty.	Value.	Year.	Rate of duty.	Value.
1909	Free	$767,183	1914[1]	Free	$726,675
1910	do	736,397	1915	do	690,343
1911	do	841,064	1916	do	1,142,721
1912	do	973,623	1917	do	1,277,783
1913	do	936,750	1918	do	1,710,566
1914	do	390,034	1919	do	770,292

[1]Act of 1913 specifies "not containing alcohol."

TABLE 34.—*Imports of all other drugs, such as beans, berries, etc., which are natural and uncompounded drugs, advanced in value or condition, 1909–1919.*

Year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	½ cent per pound plus 10 per cent.	625,899	$181,751	$19,739	$0.290	10.86
1910	do	1,512,688	266,483	30,430	.176	10.42
1911	do	1,437,008	147,311	18,323	.103	12.44
1912	do	1,550,039	152,675	19,142	.099	12.54
1913	do	1,313,562	182,732	21,557	.139	11.80
1914	do	1,544,253	104,309	14,291	.068	13.70
1914[1]	10 per cent	1,776,386	113,165	11,316	.065	10.00
1915	do	590,658	72,551	7,255	.122	10.00
1916	do	482,432	79,385	7,938	.164	10.00
1917	do	1,434,577	273,403	27,340	.190	10.00
1918	do	401,624	78,918	7,891	.196	10.00
1919	do	332,850	162,533	16,253	.488	10.00

[1]Act of 1913 specifies "and not containing alcohol."

TABLE 35.—*Imports of all other roots in a crude state, 1909-1919.*

Year.	Rate of duty.	Value.	Year.	Rate of duty.	Value.
1909	Free	$164,924	1915	Free	$200,229
1910	do	148,053	1916	do	196,577
1911	do	128,681	1917	do	228,215
1912	do	191,645	1918	do	261,147
1913	do	253,918	1919	do	347,329
1914	do	168,717			

TABLE 36.—*Imports of all other crude flowers and leaves, 1909–1919.*

Year.	Rate of duty.	Value.	Year.	Rate of duty.	Value.
1909	Free	$146,825	1915	Free	$371,296
1910	do	204,909	1916	do	252,433
1911	do	225,621	1917	do	297,308
1912	do	161,289	1918	do	466,153
1913	do	176,473	1919	do	237,160
1914	do	192,354			

TABLE 37.—*Imports of all other barks, not edible, in a crude state, and not advanced in value or condition by refining or grinding, or by other process, 1909–1919.*

Year.	Rate of duty.	Value.	Year.	Rate of duty.	Value.
1909	Free	$197,108	1915	Free	$52,866
1910	do	35,757	1916	do	55,691
1911	do	31,318	1917	do	50,482
1912	do	113,809	1918	do	52,069
1913	do	35,978	1919	do	41,274
1914	do	18,464			

II. EXOTIC DRUGS CULTIVATED IN THE UNITED STATES.

Cultivation of many of these drugs has been carried on for a number of years on an experimental scale but has assumed important proportions only during the war. While their commercial value may be considered negligible, and while small amounts are required as compared with common agricultural crops, they are nevertheless indispensable to the practice of modern medicine. The success thus far attained in the cultivation of exotic medicinal plants is largely due to the initiative of the Office of Drug, Poisonous, and Oil Plant Investigations, United States Department of Agriculture.

BELLADONNA.

Production and Trade.

Belladonna is the principal member of a series of drugs, the active alkaloidal principles of which are similar or identical. Other important members of the series are stramonium, henbane, and scopola. Belladonna is chiefly used for the preparation of the alkaloid, atropine, for the manufacture of pain-relieving plasters, and as a sedative for various purposes. The belladonna plant occurs as a weed throughout Southern Europe, whence the bulk of the world's supply was formerly derived. Extensive collection has rendered it rather scarce and cultivation has been carried on in Europe and Japan as

well as in the United States. It is a perennial, not hardy north of New York, and requires careful handling and cultivation, being very liable to insect and disease damage. The estimated domestic production for 1918 was 166,000 pounds of herb, stems, and leaves, and 22,000 pounds of root. Sixty growers were engaged in cultivation, utilizing a total of 274 acres. Yields of 600 pounds of herb, and 160 pounds of root per acre are reported. California, Michigan, Pennsylvania, and Indiana ranked in acreage in the order given. Destruction of the crop by the potato stalkborer was reported by some California growers. The market is said to have been somewhat oversupplied by domestic production.

Belladonna is valued for its alkaloids, of which, according to the United States Pharmacopœia, the leaves should contain not less than 0.3 per cent and the roots, 0.45 per cent. American cultivation is said to have furnished products considerably above this standard. Atropine and hyoscyamine are the chief alkaloids of belladonna. Atropine is of extreme importance in the surgery of the eye. It is derived chiefly from belladonna, but may also be obtained from certain related plants, particularly scopola, a substitute found in Europe and Japan. The latter has been used extensively in the manufacture of "belladonna plasters," and is believed to be important in the recently developed Japanese manufacture of atropine and related alkaloids.

Imports.

Statistics for imports of belladonna are not given in Commerce and Navigation of the United States, but during the fiscal year 1914 141,074 pounds of leaves and 65,886 pounds of roots were imported.[1] The imports of leaves and roots in 1917 amounted to approximately 33,000 pounds.

Prices.

From 14 cents per pound in 1913 the price of belladonna leaf rose to $1.85 to $2 in 1916; the price of belladonna root increased from 9 cents per pound in 1913 to $3.50 to $5 in 1917. The end of 1919 found the leaf quoted at 30–35 cents per pound and the root at 55–65 cents. This decline is thought to have been caused by the slackening of war demands and the bearish attitude on the part of the trade as much as to actual domestic oversupply or to foreign belladonna which is again appearing on the market. The alkaloid, atropine, was quoted at $55 per ounce during 1917, but since that time prices have fallen off somewhat. In April, 1920, the alkaloid was quoted at about $20 per ounce and atropine sulphate at $15 per ounce.

[1] Import figures for 1914 are given for all drugs and chemicals in Misc. Series No. 82, U. S. Dept. of Commerce.

STRAMONIUM.

Stramonium is a drug consisting of the leaves of a plant which is closely related to belladonna. The seed are also used for similar purposes. Stramonium is used as a substitute for belladonna and in the preparations for the relief of asthma. The plant is probably native to Southern Europe, but has been introduced almost universally as a weed, being known as "Jimson weed" in North America. The leaves are rather extensively collected in the Southern Appalachians, and the plant has been cultivated in California and elsewhere in America, though not as extensively as belladonna. Wild supplies are sufficient to supply all needs, but the weed occurs rather scatteringly and has been collected only in a few localities. In cultivation it requires rich soil and careful treatment, but is less exacting than belladonna. Yields of 1,000–1,500 pounds of leaf per acre are reported. Prices have ranged from 7 cents to 42 cents per pound between 1912 and 1920. The latter figure was quoted in April, 1920. During the fiscal year 1914, 171,574 pounds of stramonium leaf were imported.

HENBANE OR HYOSCYAMUS.

Henbane or hyoscyamus is another relative of belladonna. Henbane is used as a sedative in medicine and in the manufacture of the alkaloids, hyoscyamine and hyoscine. A related plant known as Egyptian henbane has similar properties, but contains no hyoscine. Extensive supplies have come in the past from wild plants of Southern and Central Europe and adjacent Asia. It has been cultivated for drug use in England, Germany and Austria. In America, however, its growth has been much less successful than that of belladonna and stramonium chiefly because of its liability to insect damage. Successful cultivation on a small scale is reported from Michigan. The plant has escaped, and grows very luxuriantly in some localities, notably Montana, but there has been no sufficient commerical incentive for the collection of the wild supply, which is found only in places where drug collection is practically unknown. In 1914 imports of 136,429 pounds, valued at $10,609, are reported. American wholesale prices have ranged from 9 cents to $5 per pound from 1912 to 1920. In April, 1920, 35–38 cents per pound was quoted.

DIGITALIS.

Digitalis is a valuable medicinal commonly grown in flower gardens as "foxglove." Digitalis is chiefly used as a heart tonic. The plant grows wild throughout a wide range in southern and central Europe, whence it was formerly shipped to the United States. The cultivation of digitalis appears to present less difficulties than that of bella-

donna or henbane, but, owing to the lesser demand, it has attracted less commercial attention. Successful production is reported from Virginia, South Carolina, Indiana, Wisconsin, Minnesota, and California, usually in small plats. The plant has also escaped and grows luxuriantly in the mountains of the Pacific Northwest, where considerable quantities were collected during the war. Owing to unfamiliarity of collectors with proper methods of collecting and handling the product, some difficulty was experienced in disposing of this crop. The production in 1917 was estimated at 10,000 pounds. The potency of American digitalis is claimed to be unusually high, and the production of a domestic supply fully equal to the demand is probably conditioned only on stabilization of price at a figure which will allow American producers to grow the plant profitably. In 1914 imports of 22,371 pounds, valued at $1,874, were received. Prices have ranged from 8 cents per pound in 1914 to 90 cents in April, 1916. In April, 1920, domestic digitalis was quoted at 22–25 cents per pound and the imported product at 30–32 cents.

CANNABIS.

Cannabis is usually known as cannabis indica, Indian hemp, or hasheesh (hashish). It was formerly imported exclusively from India, but recent experiments have shown that hemp of equal drug value can be produced in almost any subtropical region. Quantity production has taken place in Virginia and South Carolina, and probably elsewhere in the United States. Because of the high export duty levied by the Indian Government on cannabis the price of the domestic commodity has been considerably lower than that of the imported, although tests have shown the American cannabis to be fully equal to the Indian. American production is believed sufficient to supply all domestic needs. Cannabis is used in medicine to relieve pain and to produce sleep.

Cannabis may be considered, to a certain extent, as a substitute and commercial rival of opium, although the uncertainty of its action has prevented it from becoming as widely used. It produces an intoxication somewhat similar to that of alcohol, but while its habit-forming tendencies are still a matter of dispute, its continued use is admitted to produce mental and physical degeneration. Oriental Governments, especially those of India and Egypt, have found it necessary to regulate its use strictly. Cannabis, however, is the only important narcotic not included in the scope of the Harrison narcotic law. As regards Federal legislation, its use is only limited by the provisions of the food and drugs act, which require statements of its presence on the labels of medicines containing it and a Treasury decision (T. D. 35719), under which it is admitted at the ports on filing of a bond to insure its use for medicinal purposes. This lat-

ter regulation does not apply to domestic cannabis. The ease of its growth and the peculiar nature of its intoxicating effect has awakened some apprehension as to its use becoming habitual among the Negroes of the South. The use of cannabis has recently been reported as the active principle in intoxicant compounds developed as substitutes for alcoholics, the manufacture and sale of which is prohibited under recent legislation and constitutional amendment. Cannabis is used externally as an anodyne in corn cures. Imports of cannabis are not shown separately in the official statistics, but during the fiscal year 1914, 31,210 pounds of cannabis indica, valued at $26,099, were imported. England and British India furnished the bulk of the imports. The prewar price of imported cannabis was about $1.25 to $1.50 per pound. This was doubled in 1918 and in 1919 reached a maximum of $4.25 per pound. Domestic cannabis (U. S. P.) sold for 60–80 cents during 1918 and 1919; in April, 1920, it was quoted at about 35 cents per pound.

LEVANT WORMSEED OR SANTONICA.

The production of Levant wormseed or santonica has recently assumed considerable interest. This drug is the flower of a plant native to Asia Minor, where it was formerly collected in large amounts under the supervision of the Russian Imperial Government for the manufacture of santonin. This manufacture was formerly a prerogative of the Russian Crown, and was leased out for a period of years to a commercial firm. The last agreement (in 1911) was for a five-year period. The revenue to the Crown was fixed at $25,300 per year as against $2,575 per year for the preceding period. Collections of santonica beyond the needs of the Government factory were exported. The factory purchased usually 1,800,000 to 2,160,000 pounds annually; in 1912 only 1,440,000 pounds were purchased and 720,000 pounds exported. In later years, previous to the war, the manufacture is believed to have come, to some extent at least, into German hands. The supplies of Levant wormseed and santonin derived therefrom were interrupted by internal disturbances in Russia in 1916, and since that time there has been little foreign santonin in the American markets.

Santonin has been known for a number of years as a worm expeller, but its use for this purpose in human medicine was not sufficient to demand large amounts. About 1917, however, it was discovered that santonin was a valuable material for ridding hogs of worms.

It has been demonstrated that a small dose of santonin, which will free a hog of intestinal worms, is followed by much more rapid growth in proportion to the food consumed. The large demand for this purpose has been largely responsible for the enormous increase in the price of santonin.

Prices and Domestic Production.

The price of wormseed has ranged from 19 cents per pound in 1912 to $1.50 in 1916. Levant wormseed was quoted at $1.30 in June, 1920. From a prewar price of $25 per pound, the price of santonin has risen to $175 (June 21, 1920). The high price of santonin and the large field for its use have, therefore, occasioned much interest in the cultivation of Levant wormseed. In America a single firm has experimentally undertaken it, and reports promising results on a small scale.

Imports.

The imports of wormseed are not shown in the published statistics, but in 1914, 81,482 pounds, valued at $24,356, were received principally from Russia and Germany. Imports of the prepared santonin and its salts are shown in Table 38.

TABLE 38.—*Imports for consumption in the United States, 1909–1919.*

A.—SANTONIN AND ALL SALTS OF, CONTAINING 80 PER CENT OR MORE OF SANTONIN (ACTS OF 1897 AND 1909).

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	$1 per pound	7,257	$15,549	$7,257	$2.14	46.67
1910 [1]	do	110	222	110	2.02	49.55
1910 [2]	50 cents per pound	7,281	52,553	3,640	7.22	6.93
1911	do	4,291	39,678	2,145	9.25	5.41
1912	do	3,090	39,956	1,545	12.93	3.87
1913	do	1,981	44,358	990	22.39	2.23
1914	do	1,762	41,674	881	23.64	2.12

[1] Act of 1897, July 1 to Aug. 5, 1909. [2] Act of 1909, Aug. 6, 1909, to June 30, 1910.

B.—SANTONIN AND ITS COMBINATIONS WITH ACIDS NOT SUBJECT TO DUTY (ACT OF 1913).

		Pounds.				*Per cent.*
1914	Free	3,467	$83,454	.....	$24.07	.....
1915	do	912	25,558	.....	28.02	.....
1916	do	20,925	586,850	.....	28.04	.....
1917	do	111	3,966	.....	35.73	.....
1918	do	223	7,502	.....	33.64	.....
1919	do	1,125	49,688	.....	44.17	.....

VALERIAN.

Valerian root is cultivated and also grows wild in England and continental Europe. It is used as a sedative in nervous diseases and is a common ingredient of remedies for the diseases of women. The plant thrives well under experimental conditions in America, and is understood to have been commercially produced on a small scale. Valerian is cultivated on a rather extensive scale in Holland, Belgium, Germany, France, Austria, England, and Japan. Yields of 2,000 pounds or more of the roots and rhizomes per acre are reported. Imports are not shown separately in the official statistics, but in 1914 amounted to 66,233 pounds, valued at $4,357.

The English valerian normally brings the highest price, but since 1917 the Belgian and Japanese products have supplied the American market. The prices of Belgian valerian root have ranged from 10 cents per pound in 1914 to $1.50–$1.65 in 1919. It was quoted at about 30 cents per pound in April, 1920.

MARJORAM.

Marjoram is a small herb native to Europe and Asia. It is cultivated extensively in Southern Europe and collected either for drug or culinary purposes, or for the essential oil which may be distilled from it. In the United States it is grown as a garden herb, while certain varieties grow as weeds along the roadsides. An inferior variety is imported under the name of origanum. It is occasionally used in domestic medicine, but usually more as a condiment than as a medicine. Imports, which come principally from France and Central Europe, amounted in 1914 to 133,653 pounds, valued at $8,445. The two varieties on the American market are known as French and German marjoram. The German variety sold for 20–25 cents per pound before the war and the French variety at 10–12 cents. Prices increased greatly during the war, and in April, 1920, French marjoram was quoted at about 35 cents and the German at 50 cents per pound.

SAGE.

Sage is an herb native to Europe, where it occurs wild and is also cultivated. Several varieties are sold on the American market; Greek and Spanish sage are usually considered inferior by American taste. Sage has been rather extensively cultivated in America, and the American product bears a high reputation for quality and purity. Sage is used extensively as a condiment, in meat packing, poultry seasoning, and other culinary uses. It has some reputation as a domestic remedy, especially in ailments of children. Imports, which come principally from Southern Europe, are shown in Table 39. Prior to the war Spanish and Greek sage sold for about 3–5 cents per pound. In 1915 the price of these varieties increased to about 30 cents per pound, but have since fallen off to about 12 to 15 cents. Domestic sage commands a slightly higher price.

TABLE 39.—*Imports of sage for consumption in the United States (1909–1919).*

Fiscal year.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate
		Pounds.				*Per cent.*
1909	1 cent per pound	1,435,320	$25,813	$14,353	$0.018	55.60
1910	do	1,354,594	23,562	13,545	.017	57.49
1911	do	1,278,340	22,578	12,788	.020	56.64
1912	do	1,518,124	24,496	15,181	.016	61.98
1913	do	1,299,119	19,893	12,991	.015	65.31
1914 [1]	do	246,390	4,732	2,463	.020	52.07
1914 [2]	½ cent per pound plus 20 per cent [3]	10,385	294	113	.027	38.51
	½ cent per pound [4]	1,747,194	34,282	8,735	.020	25.48
1915	½ cent per pound plus 20 per cent [3]	214	45	10	.210	22.38
	½ cent per pound [4]	822,083	48,454	4,110	.059	8.48
1916	½ cent per pound plus 20 per cent [3]	15	6	1	.400	21.33
	½ cent per pound [4]	1,865,815	130,464	9,329	.070	7.15
1917	½ cent per pound plus 20 per cent [3]	30	29	5	.970	20.51
	½ cent per pound [4]	1,528,828	92,409	7,644	.060	8.27
1918	½ cent per pound plus 20 per cent [3]					
	½ cent per pound [4]	1,364,295	150,004	6,821	.110	4.55
1919	½ cent per pound plus 20 per cent [3]	45	48	10	1.066	20.83
	½ cent per pound [4]	977,440	143,257	4,887	.146	3.41

[1] Act of 1909, July 30, 1913, to Oct. 3, 1913.
[2] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[3] Ground.
[4] Unground.

PYRETHRUM, DALMATIAN, OR INSECT FLOWERS.

Insect flowers have been cultivated for some years in a small way by a single firm in California. They are produced in considerable quantities in Dalmatia, Austria, but in recent years a very extensive cultivation has been carried on in Japan, which country now dominates the world market. As the name indicates, insect flowers are chiefly used as an insecticide, particularly against household and library insects; they are rarely or never used in medicine.

Imports of pyrethrum were not published in Commerce and Navigation of the United States prior to 1916. The rapidly increasing importance of the commodity, however, is shown by the considerable increase in imports, which are given in Table 40. The closed variety of insect flowers increased in price from 32–34 cents per pound in 1914 to 55 cents in 1916. Powdered insect flowers in April, 1920, were quoted at $1 per pound.

TABLE 40.—*Imports of pyrethrum or insecticide flowers for consumption in the United States, 1916–1919.*

Fiscal year.	Rates of duty.	Quantities.	Values.	Value per unit of quantity.
		Pounds.		
1916 [1]	Free	296,644	$44,137	$0.149
1917	do	1,504,871	311,999	.207
1918	do	2,298,476	422,751	.184
1919	do	3,399,026	667,374	.196

[1] In 1914, 503,189 pounds valued at $90,435 were imported, coming principally from Austria-Hungary and Germany.

III. INDIGENOUS DRUGS.

Very few native drugs are commercially cultivated in the United States. Several hundred botanical products have been collected on a commercial scale, but at present comparatively few are of real importance, and the list seems unlikely to be greatly enlarged in the near future. The greater number of items enter trade from the Southern Appalachian region, where they have been extensively collected, chiefly by women and children at odd times. The industry has been dependent on cheap labor of this class which, previous to the war, had relatively little other remunerative outlet. Prewar prices were extremely low, and offered little inducement to systematic collection, even in this region where labor returns were probably lower than elsewhere in the United States. During the war, the draft and new industrial opportunities claimed many of the men of the region, and the women and children, in large part, were forced to take their places in farm labor, or were drawn into industries in the towns. Increased prices for farm produce, and increased wages have rendered the workers more or less independent of their former desultory occupation of drug gathering. Collections have accordingly fallen off, even though the prices of botanicals, stimulated by war demand, influenza, and lack of foreign materials, have risen far above previous quotations. Prices still rule high, and have shown little of the tendency to decrease which has been manifested by some other medicinals.

GINSENG.

The ginseng plant formerly grew wild throughout the forests of the Eastern, Central, and Southern States. Extensive collection almost extirpated the wild plant, however, and supplies are now drawn chiefly from eastern and southern New York, the Dakotas, and Minnesota, and to a less extent from the Southern Appalachians. Considerable cultivation has also been practiced. Ginseng requires especially expensive methods of cultivation; a few growers have reaped large profits, but many plantations have failed entirely. The wild root brings a much higher price than the cultivated, and has reached $15 per pound at a time when the cultivated was selling for about $5 per pound. Prices for the different varieties of ginseng are shown in Table 41. Ginseng is collected exclusively for the Chinese trade; occidental therapeutists deem it valueless. Imports of ginseng have been very small and statistics are not published in Commerce and Navigation of the United States. Exports since 1909 have averaged about 195,000 pounds valued at over a million dollars. Over 95 per cent of the exports are shipped to China as may be noted in Table 42.

No exact statistics of exportation or production of other individual American crude drugs are available. Values of "All other roots, herbs, and barks" exported for the years 1909–1918 are given in Table 43. These products in prewar years went chiefly to Germany. Since the war, England has greatly predominated in our export trade, Canada ranking second.

TABLE 41.—*Wholesale prices of ginseng at New York, 1912–1920.*

[Dollars per pound.]

	Cultivated.	Wild northwestern.	Wild southern.	Wild eastern.
1912.				
January	6.00	6.00– 6.25	5.50–5.75	6.25–6.50
April	6.00	5.50	5.50	6.00
July	6.00–6.50	5.50	4.75– 5.00	6.00
October	6.50–7.50	6.50	5.50– 6.00	7.00–7.25
1913.				
January	5.50–6.00	7.25– 7.50	7.00– 7.25	7.25–7.50
April	5.50–6.00	7.25– 8.00	7.00– 7.25	7.25–8.00
July	5.00–5.50	6.25– 7.00	6.00– 6.25	6.25–7.00
October	5.00–5.50	6.25– 7.00	6.00– 6.25	6.25–7.00
1914.				
January	5.00–5.50	6.25– 7.00	6.00– 6.25	6.25–7.00
April	5.00–5.50	6.25– 7.00	6.00– 6.25	6.25–7.00
July	5.00–5.50	6.25– 7.00	6.00– 6.25	6.25–7.00
October	5.00–5.50	7.25– 7.50	7.00– 7.25	7.00–7.25
1915.				
January	5.00–5.50	7.25– 7.50	7.00– 7.25	7.00–7.25
April	5.00–5.50	7.25– 7.50	7.00– 7.25	7.00–7.25
July	5.00–5.50	7.25– 7.50	7.00– 7.25	7.00–7.25
October	5.00–5.50	7.25– 7.50	7.00– 7.25	7.00–7.25
1916.				
January	5.00–5.50	7.25– 7.50	7.00– 7.25	7.00–7.25
April	5.00–5.50	7.24– 7.50	7.00– 7.25	7.00–7.25
July	5.00–5.50	7.25– 7.50	7.00– 7.25	7.00–7.25
October	4.25–5.50	6.50– 6.75	6.25– 6.50	6.25–6.50
1917.				
January	4.25–5.50	6.50– 6.75	6.25– 6.50	6.25–6.50
April	4.25–5.50	6.50– 6.75	6.25– 6.50	6.25–6.50
July	4.25–5.50	6.50– 6.75	6.25– 6.50	6.25–6.50
October	4.25–5.50	6.50– 6.75	6.25– 6.50	6.25–6.50
1918.				
January	4.25–5.50	6.50– 6.75	.....	.....
April	4.25–5.50	6.50– 6.75	6.25– 6.50	6.25–6.50
July	4.50–5.00	.....	6.25– 6.50	.....
October	4.50	.....	.....	.....
1919.				
January	4.50	12.00–15.00	7.50–12.00	.....
April	4.50	.....	.....	.....
July	4.50	.....	.....	.....
October	4.50–6.50	15.00–20.00	12.00–15.00	.....
1920.				
January	4.50–6.50	15.00–20.00	12.00–15.00	.....
April	4.50–6.50	15.00–20.00	12.00–15.00	.....

TABLE 42.—*Domestic exports of ginseng, 1909–1918.*

Exported to—	1909		1910		1911	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Canada	.....	.....	190	1,403	22	152
China	1,597	10,050	152	827	50	220
Hongkong	184,550	1,259,429	192,002	1,436,761	153,927	1,067,830
Japan	.....	.....	50	378	.....	.....
Philippine Islands	.....	.....	12	65	.....	.....
All others	111	700	.....	.....	.....	.....
Total	186,258	1,270,179	192,406	1,439,434	153,999	1,088,202

Exported to—	1912		1913		1914	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Canada	66	396	90	435	2,059	11,205
China	30	100	280	1,153	333	2,221
Hongkong	154,749	1,115,964	219,443	1,649,610	220,767	1,810,901
Japan	51	300	140	630	200	800
Philippine Islands	390	2,463	185	765	1,081	6,682
All others	22	78	1,763	13,138	165	877
Total	155,308	1,119,301	221,901	1,665,731	224,605	1,832,686

Exported to—	1915		1916		1917	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Canada	1,169	8,490	1,006	3,989	4,910	26,271
China	3,916	33,777	14,252	90,788	12,763	74,049
Hongkong	97,596	875,720	240,229	1,499,378	180,243	1,282,151
Japan	503	1,944	356	1,593	77	200
Philippine Islands	.....	.....	217	1,690	371	2,779
All others	.....	.....	12	70	116	753
Total	103,184	919,931	256,082	1,597,508	198,480	1,386,203

Exported to—	1918	
	Pounds.	Dollars.
Canada	84,851	529,646
China	47,727	329,013
Hongkong	123,390	852,212
Japan	.....	.....
Philippine Islands	175	806
All others	3,749	25,869
Total	259,892	1,717,548

TABLE 43.—*Domestic exports of all other crude roots, herbs, and barks, 1909–1918.*

Exported to—	1909	1910	1911	1912	1913
Austria-Hungary	$8,707	$9,510	$10,895	$2,528	$3,149
France	24,662	32,520	37,411	38,682	40,957
Germany	176,926	191,864	208,138	197,164	145,039
Italy	18,565	22,094	16,244	11,594	8,974
Netherlands	10,522	18,268	11,796	8,633	14,378
Russia in Europe	7,682	8,458	27,178	30,736	13,527
England	101,154	120,376	133,301	162,966	135,789
Canada	15,520	29,752	36,323	63,100	44,792
Mexico	4,754	6,740	4,227	8,369	3,068
Cuba	759	3,405	1,937	1,525	945
Japan	12,397	18,058	12,456	12,754	2,967
Australia and Tasmania	3,315	1,744	2,029	3,866	2,172
Argentina	915	1,087	717	.....	.....
Brazil	570	148	.....	.....	.....
Chile	925	119	.....	12	7
All others	8,427	12,694	11,210	7,948	8,548
Total	395,801	476,837	563,862	549,877	424,312

Exported to—	1914	1915	1916	1917	1918
Austria-Hungary	$1,725	$1,370	.....	.....	.....
France	44,617	35,447	$115,912	$145,592	$16,891
Germany	201,105	17,445	.....	.....	.....
Italy	15,711	32,136	43,095	38,323	32,452
Netherlands	29,296	7,485	8,787	3,654	.....
Russia in Europe	6,972	7,867	31,041	17,608	8,295
England	109,691	239,601	294,370	280,814	179,791
Canada	58,864	52,150	40,949	93,849	151,996
Mexico	1,674	585	2,599	18,034	16,852
Cuba	2,063	953	7,805	6,634	28,173
Japan	12,996	19,085	45,835	64,036	96,286
Australia	8,577	1,225	17,079	22,625	22,310
Argentina	15,719	10,120	27,983	16,326	23,334
Brazil	.....	530	9,721	10,569	10,484
Chile	77	872	10,531	22,014	26,441
All others	3,984	43,219	174,270	112,178	171,209
Total	513,071	470,090	768,977	852,256	784,514

CASCARA SAGRADA.

Cascara sagrada is the bark of a small tree native to the Pacific slope. In therapeutic importance it probably ranks first among American native medicinals. No statistics of production are available, but the United States Dispensatory has estimated that 3,000,000 to 4,000,000 pounds are annually collected from the uncultivated trees. As yet the commercial cultivation of cascara is merely experimental, but the present rate of collection is expected to make serious inroads upon the wild supply within a few years. Cascara is used as a laxative and cathartic; its medicinal action is closely allied to that of imported rhubarb and senna. Import and export statistics are not shown separately. The wholesale prices of cascara sagrada, which are shown in Table 44, have ranged in recent years from 7 cents to 20 cents per pound.

TABLE 44.—*Wholesale prices of cascara sagrada, New York, 1912–1919.*

[Cents per pound.]

1912:		1916:	
January	9 -10½	January	6½- 9
April	9 -10½	April	7½-12
July	9½-10½	July	7½-12
October	8 -10	October	7½-10
1913:		1917:	
January	8 -10	January	8½-10
April	7½- 9	April	11½-13
July	7½-10	July	12½-14
October	7½-10	October	12½-14
1914:		1918:	
January	7½-10	January	12½-15
April	7½-10	April	14 -16
July	7½-10	July	15 -16
October	8 -10½	October	19 -20
1915:		1919:	
January	7½- 9½	January	18½-19
April	7½-10	April	18½-19
July	7½-10	July	18 -19
October	7 - 7½	October	17 -20

GOLDENSEAL OR HYDRASTIS.

The wild goldenseal or hydrastis plant was formerly abundant in the Ohio Valley, but is now becoming rare. Cultivation is practiced to some extent in the United States and has also received some attention in Austria and Italy. Apparently, however, no commercial supplies are yet forthcoming from foreign sources. From 200,000 to 300,000 pounds of the underground stem and roots are said to be collected annually (U. S. Dispensatory). It owes its medicinal value to the alkaloids, hydrastine, and berberine, which are prepared from it. Hydrastis is chiefly used in catarrhal affections of the mucous membrane. Prices of powdered goldenseal root have shown but slight variation since 1912; the lowest price was $4 per pound quoted in July, 1913, and the highest $6.50 in October, 1916.

OTHER AMERICAN DRUGS.

Wild cherry bark.—This is the bark of the black cherry, a valuable lumber tree. It is extensively collected in the Southern Appalachians, for use in cough mixtures.

White pine bark.—This is the bark of young trees of the white or Weymouth pine, the species chiefly valued for timber. It is used in cough medicines. Both it and wild cherry bark were in unusual demand during the war, especially during the influenza epidemic.

Podophyllum or mandrake.—The underground stem and roots of a small, herbaceous plant, which grows wild in the Central and Eastern States, are commonly known as mandrake. Considerable quantities are used as a cathartic, usually in mixtures with aloes and cascara.

Sanguinaria or bloodroot.—This is a common plant of eastern swamps, whose underground stem and roots are used in bronchial complaints.

Red clover flowers.—The heads of the common red clover are collected in the southern Appalachians and used in "blood purifiers." They have, however, no medicinal value. The collection of "clover tops" in the United States has been considerably stimulated by the cutting off of the German supplies.

Other native drugs of some commercial importance include lobelia, senega, pink root, wahoo bark, and slippery elm.

REFERENCES.

The Commission has in its files in manuscript form Tariff Information Surveys on the individual drugs discussed in this report. The following are the principal sources from which information has been drawn:

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APPENDIX

PROVISIONS IN THE TARIFF ACT OF OCTOBER 3, 1913, FOR DRUGS AND RELATED PRODUCTS.

SCHEDULE A.

1. Acids: Boracic acid, ¼ cent per pound; citric acid, 5 cents per pound; formic acid, 1½ cents per pound; gallic acid, 6 cents per pound; lactic acid, 1½ cents per pound; oxalic acid, 1½ cents per pound; pyrogallic acid, 12 cents per pound; salicylic acid, 2½ cents per pound; tannic acid and tannin, 5 cents per pound; tartaric acid, 3½ cents per pound; all other acids and acid anhydrides not specially provided for in this section, 15 per centum ad valorem.

5. Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof not specially provided for in this section, 15 per centum ad valorem.

8. Argols or crude tartar or wine lees crude or partly refined, containing not more than 90 per centum of potassium bitartrate, 5 per centum ad valorem; containing more than 90 per centum of potassium bitartrate, cream of tartar, and Rochelle salts or tartrate of soda and potassa, 2½ cents per pound; calcium tartrate crude, 5 per centum ad valorem.

9. Balsams: Copaiba, fir or Canada, Peru, tolu, and all other balsams, which are natural and uncompounded and not suitable for the manufacture of perfumery and cosmetics, if in a crude state, not advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the balsams and the prevention of decay or deterioration pending manufacture, all the foregoing not specially provided for in this section, 10 per centum ad valorem; if advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the balsams and the prevention of decay or deterioration pending manufacture, all the foregoing not specially provided for in this section, 15 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

13. Caffein, $1 per pound; compounds of caffein, 25 per centum ad valorem; impure tea, tea waste, tea siftings or sweepings, for manufacturing purposes in bond, pursuant to the provisions of the Act of May sixteenth, nineteen hundred and eight, 1 cent per pound.

14. Calomel, corrosive sublimate, and other mercurial preparations, 15 per centum ad valorem.

15. Chalk, precipitated, suitable for medicinal or toilet purposes; chalk put up in the form of cubes, blocks, sticks, or disks, or otherwise, including tailors', billiard, red, and other manufactures of chalk not specially provided for in this section, 25 per centum ad valorem.

16. Chemical and medicinal compounds and preparations, including mixtures and salts, distilled oils, essential oils, expressed oils, rendered oils, greases, ethers, flavoring and other extracts and fruit essences, all the foregoing and their combinations when containing alcohol, and all articles consisting of vegetable or mineral objects immersed or placed in, or saturated with, alcohol, except perfumery and spirit varnishes, and all alcoholic compounds not specially provided for in this section, if containing 20 per centum of alcohol or less, 10 cents per pound and 20 per centum ad valorem; containing more than 20 per centum and not more than 50 per centum of alcohol, 20 cents per pound and 20 per centum ad valorem; containing more than 50 per centum of alcohol, 40 cents per pound and 20 per centum ad valorem.

17. Chemical and medicinal compounds, combinations and all similar articles dutiable under this section, except soap, whether specially provided for or not, put up in individual packages of two and one-half pounds or less gross weight (except samples without commerial value) shall be dutiable at a rate not less than 20 per centum ad valorem: *Provided*, That chemicals, drugs, medicinal and similar substances, whether dutiable or free, imported in capsules, pills, tablets, lozenges, troches, ampoules, jubes, or similar forms, shall be dutiable at not less than 25 per centum ad valorem.

18. Chloral hydrate, salol, phenolphthalein, urea, terpin hydrate, acetanilid, acetphenetidin, antipyrine, glycerophosphoric acid, and salts and compounds thereof, acetylsalicylic acid, aspirin, guiacol carbonate, and thymol, 25 per centum ad valorem.

19. Chloroform, 2 cents per pound; carbon tetrachloride, 1 cent per pound.

27. Drugs, such as barks, beans, berries, buds, bulbs, bulbous roots, excrescences, fruits, flowers, dried fibers, dried insects, grains, gums, herbs, leaves, lichens, mosses, roots, stems, vegetables, seeds (aromatic, not garden seeds), seeds of morbid growth, and weeds; any of the foregoing which are natural and uncompounded drugs and not edible, and not specially provided for in this section, but which are advanced in value or condition by shredding, grinding, chipping, crushing, or any other process or treatment whatever beyond that essential to the proper packing of the drugs and the prevention of decay or deterioration pending manufacture, 10 per centum ad valorem: *Provided:* That no article containing alcohol shall be classified for duty under this paragraph.

28. Ergot, 10 cents per pound.

29. Ethers: Sulphuric, 4 cents per pound; amyl nitrite, 20 per centum ad valorem; amyl acetate and ethyl acetate or acetic ether, 5 cents per pound; ethyl chloride, 20 per centum ad valorem; ethers and esters of all kinds not specially provided for in this section, 20 per centum ad valorem: *Provided,* That no article containing more than 10 per centum of alcohol shall be classified for duty under this paragraph.

31. Extract of chlorophyll, 15 per centum ad valorem; saffron and safflower, and extract of, and saffron cake, 10 per centum ad valorem: *Provided,* That no article containing alcohol shall be classified for duty under this paragraph.

35. Glycerin, crude, not purified, 1 cent per pound; refined, 2 cents per pound.

36. Gums: Amber, and amberoid unmanufactured, or crude gum, not specially provided for in this section, $1 per pound; arabic, or senegal, ½ cent per pound; camphor, crude, natural, 1 cent per pound; camphor, refined and synthetic, 5 cents per pound; chicle, crude, 15 cents per pound; refined or advanced in value by drying, straining, or any other process or treatment whatever beyond that essential to the proper packing, 20 cents per pound; dextrine, made from potato starch or potato flour, 1¼ cents per pound; dextrine, not otherwise provided for, burnt starch or British gum, dextrine substitutes, and soluble or chemically treated starch, ¾ of 1 cent per pound.

38. Iodoform, and potassium iodide, 15 cents per pound.

39. Leaves and roots: Buchu leaves, 10 cents per pound; coca leaves, 10 cents per pound; gentian, ¼ cent per pound; licorice root, ¼ cent per pound; sarsaparilla root, 1 cent per pound.

40. Licorice, extracts of, in pastes, rolls, or other forms, 1 cent per pound.

42. Magnesia: Calcined, 3½ cents per pound; carbonate of, precipitated, 1½ cents per pound; sulphate of, or Epsom salts, $\frac{1}{10}$ cent per pound.

43. Menthol, 50 cents per pound.

44. Oils, rendered: Sod, seal, herring, and other fish oil, not specially provided for in this section, 3 cents per gallon; whale oil, 5 cents per gallon; sperm oil, 8 cents per gallon; wool grease, including that known commercially as degras or brown wool grease, crude and not refined or improved in value or condition, ½ cent per pound; refined or improved in value or condition, and not specially provided for in this section, ½ cent per pound; lanolin, 1 cent per pound; all other animal oils, rendered oils and greases, and all combinations of the same, not specially provided for in this section, 15 per centum ad valorem.

45. Oils, expressed: Alizarin assistant, sulphoricinoleic acid, and ricinoleic acid, and soaps containing castor oil, any of the foregoing in whatever form, and all other alizarin assistants and all soluble greases used in the processes of softening, dyeing, or finishing, not specially provided for in this section, 25 per centum ad valorem; castor oil, 12 cents per gallon; flaxseed and linseed oil, raw, boiled, or oxidized, 10 cents per gallon of 7½ pounds; poppy-seed oil, raw, boiled, or oxidized, rapeseed oil, and peanut oil, 6 cents per gallon; hempseed oil, 3 cents per gallon; almond oil, sweet, 5 cents per pound; sesame or sesamum seed or bean oil, 1 cent per pound; olive oil, not specially provided for in this section, 20 cents per gallon; olive oil, in bottles, jars, kegs, tins, or other packages having a capacity of less than five standard gallons each, 30 cents per gallon; all other expressed oils and all combinations of the same, not specially provided for in this section, 15 per centum ad valorem.

46. Oils, distilled and essential: Orange and lemon, 10 per centum ad valorem; peppermint, 25 cents per pound; mace oil, 6 cents per pound; almond, bitter; amber; ambergris; anise or anise seed; bergamot; camomile; caraway; cassia; cinnamon; cedrat; citronella and lemon-grass; civet; fennel; jasmine or jasimine; juniper; lavender, and aspic or spike lavender; limes; neroli or orange flower; origanum, red or white; rosemary or anthoss; attar of roses; thyme; and valerian; all the foregoing oils

and all fruit ethers, oils, and essences, and essential and distilled oils and all combinations of the same, not specially provided for in this section, 20 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

47. Opium, crude or unmanufactured, and not adulterated, containing 9 per centum and over of morphia, $3 per pound; opium of the same composition, dried to contain 15 per centum or less of moisture, powdered, or otherwise advanced beyond the condition of crude or unmanufactured, $4 per pound; morphia or morphine, sulphate of, and all alkaloids of opium, and salts and esters thereof, $3 per ounce; cocaine, ecgonine, and all salts and derivatives of the same, $2 per ounce; aqueous extract of opium, for medicinal uses, and tincture of, as laudanum, and other liquid preparations of opium, not specially provided for in this section, 60 per centum ad valorem; opium containing less than 9 per centum of morphia, $6 per pound; but preparations of opium deposited in bonded warehouses shall not be removed therefrom without payment of duties, and such duties shall not be refunded: *Provided*, That nothing herein contained shall be so construed as to repeal or in any manner impair or affect the provisions of an act entitled "An act to prohibit the importation and use of opium for other than medicinal purposes," approved February ninth, nineteen hundred and nine.

65. Salts and all other compounds and mixtures of which bismuth, gold, platinum, rhodium, silver, or tin constitute the element of chief value, 10 per centum ad valorem.

70. Vanillin, 10 cents per ounce; vanilla beans, 30 cents per pound; tonka beans, 25 cents per pound.

67. Soda: Benzoate of, 5 cents per pound; chlorate of, and nitrite of, ½ cent per pound; bicarbonate of, or supercarbonate of, or saleratus, and other alkalies containing 50 per centum or more of bicarbonate of soda; hydrate of, or caustic; phosphate of; hyposulphite of; sulphid of, and sulphite of, ¼ cent per pound; chromate and bichromate of, and yellow prussiate of, ¼ cent per pound; borate of, or borax refined; crystal carbonate of, monohydrate, and sesquicarbonate of; sal soda, and soda crystals, ½ cent per pound; and sulphate of soda crystallized, or Glauber salts, $1 per ton.

SCHEDULE C.

144. Antimony, as regulus or metal, and matte containing antimony but not containing more than 10 per centum of lead, 10 per centum ad valorem; antimony oxide, salts, and compounds of, 25 per centum ad valorem.

SCHEDULE G.

233. Dandelion root, and acorns prepared, and articles used as coffee, or as substitutes for coffee, not specially provided for in this section, 2 cents per pound.

235. Spices, unground: Cassia buds, cassia, and cassia vera; cinnamon and cinnamon chips; ginger root, unground and not preserved or candied; nutmegs; pepper, black or white; capsicum or red pepper, or cayenne pepper; and clove stems, 1 cent per pound; cloves, 2 cents per pound; pimento, ¼ of 1 cent per pound; sage, ½ cent per pound; mace, 8 cents per pound; Bombay or wild mace, 18 cents per pound; ground spices, in each case, the specific duty per pound enumerated in the foregoing part of this paragraph for unground spices, and in addition thereto a duty of 20 per centum ad valorem; mustard, ground or prepared, in bottles or otherwise, 6 cents per pound; all other spices not specially provided for in this section, including all herbs or herb leaves in glass or other small packages for culinary use, 20 per centum ad valorem.

SCHEDULE H.

249. All mineral waters and all imitations of natural mineral waters, and all artificial mineral waters not specially provided for in this section, in bottles or jugs containing not more than one-half pint, 10 cents per dozen bottles; if containing more than one-half pint and not more than one pint, 15 cents per dozen bottles; if containing more than one pint and not more than one quart, 20 cents per dozen bottles; if imported in bottles or in jugs containing more than one quart, 18 cents per gallon; if imported otherwise than in bottles or jugs, 8 cents per gallon; and in addition thereto, on all of the foregoing, duty shall be collected upon the bottles or other containers at one-third of the rates that would be charged thereon if imported empty or separately.

FREE LIST.

388. Aconite.

400. Antitoxins, vaccine virus, and all other serums derived from animals and used for therapeutic purposes.

402. Arrowroot in its natural state and not manufactured.
405. Asafetida.
409. Balm of Gilead.
410. Barks, cinchona or other, from which quinine may be extracted.
421. Blue vitriol, or sulphate of copper; acetate and subacetate of copper or verdigris.
442. Castor or castoreum.
454. Cocculus indicus.
473. Dandelion roots, raw, dried or undried, but unground.
515. Iodine, crude, or resublimed.
516. Ipecac.
519. Jalap.
541. Manna.
544. Marshmallow or althea root, leaves, or flowers, natural or unmanufactured.
558. Nux vomica.
561. Oils: Birch tar, cajeput, coconut, cod, cod-liver, cottonseed, croton, ichthyol, juglandium, palm, palm-kernel, perilla, soya-bean, and olive oil rendered unfit for use as food or for any but mechanical or manufacturing purposes, by such means as shall be satisfactory to the Secretary of the Treasury and under regulations to be prescribed by him; Chinese nut oil, nut oil or oil of nuts not specially provided for in this section; petroleum, crude or refined, and all products obtained from petroleum, including kerosene, benzine, naphtha, gasoline, paraffin, and paraffin oil; and also spermaceti, whale, and other fish oils of American fisheries, and all fish and other products of such fisheries.
584. Quinia, sulphate of, and all alkaloids or salts of cinchona bark.
585. Radium and salts of, radioactive substitutes, selenium and salts of.
591. Salicin.
592. Salep, or salop.
594. Santonin, and its combinations with acids not subject to duty under this section.
595. Seeds: Cardamom, cauliflower, celery, coriander, cotton, cummin, fennel, fenugreek, hemp, hoarhound, mangelwurzel, mustard, rape, Saint John's bread or bean, sorghum, sugar beet, and sugar cane for seed; bulbs and bulbous roots; not edible and not otherwise provided for in this section; all flower and grass seeds; coniferous evergreen seedlings; all the foregoing not specially provided for in this section.
616. Strychnia or strychnine, and its combinations with acids not subject to duty under this section.
617. Sulphur in any form, brimstone, and sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur.
635. Turpentine, Venice, and spirits of.

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ERGOT.

[Par. 28, act of 1913.]

SUMMARY.

Description.—Ergot is a crude botanical drug consisting of a fungus growth on the rye plant. It is an important drug in obstetrical practice, in which it has legitimate use, although it is sometimes used illegally as an abortifacient.

Domestic production.—Ergot occurs as a disease of rye throughout the rye-growing section of the United States, notably in Minnesota, the Dakotas, and adjacent States. Its removal from rye is rendered imperative by its poisonous nature. Separation is effected by screening. The ergot thereby becomes mixed with other refuse, and owing to high American labor cost its separation and collection for medicinal use has, up to the present (1919), not proved commercially feasible, although more than enough doubtless occurs in this country to supply all domestic needs.

Foreign production.—Ergot occurs in all rye-growing countries, and is chiefly collected by cheap hand labor in Russia, Spain, Germany, Austria, and Sweden.

Imports.—American imports are drawn chiefly from Russia and Spain, both direct and, in normal times, also via England and Germany. Spanish and Russian ergot enter the American market in about equal amounts; the former is commercially preferred, as it is handled with greater care. Imports are usually consumed soon after arrival, as the drug deteriorates rapidly. Manufactured preparations of ergot, which compete with similar American preparations more directly than does the raw material with American ergot, come from France and Germany.

Imports of recent years have varied widely in both volume and price, as this commodity is usually dependent on seasonal conditions in the producing countries, as well as having been directly and indirectly affected by the war. For the years 1909–1918 an average amount of 164,644 pounds and an average value of $99,193 is reported.

Since the imposition of duty on ergot by the act of 1913, it has yielded an average annual revenue (1914–1918) of $14,689.

Prices.—Declared value has varied between 27 cents per pound in 1909 and 93 cents in 1912, being given as 49 cents in 1917. American wholesale prices since 1912 have varied between 78 cents in December, 1917, and $2.75 in September, 1914; but prior to 1918 they rarely passed $1.25, the variation in price due to seasonal conditions and the difficulties in importation. In December, 1918, $2.50 and $2.55 was quoted for both grades.

Tariff history.—Ergot was specifically made dutiable at 20 cents per pound by the act of July 14, 1862, and placed on the free list of the act of June 6, 1872, where it remained on all succeeding tariffs till the adoption of the act of 1913.

The specific tax of 10 cents per pound assessed by the act of 1913 has been equivalent to an ad valorem of from 15.35 to 20.55 (1914-1917).

General Information.

Ergot is a crude botanical drug consisting of the dried sclerotium (or resting body) of a fungus (*Claviceps purpurea*), which is a parasitic disease of rye.

Synonyms.—Ergota, U. S. P. Spurred Rye, Ergot of Rye, *Eng.* Secale cornutum, Mutterkoln, *Ger.* Ergot de seigle, Seigle ergote (noir), Ble cornu., *Fr.*

Sources and grades.—While the range of ergot is practically coincident with that of the rye crop, commercial supplies in the past have come almost wholly from Spain and Russia. Spanish and Russian ergots are the only grades recognized by the trade. Minor supplies from Germany, Switzerland, Sweden, and Austria greatly resemble the Russian product, and are usually sold as Russian. Importations of each grade are of about equal amounts. Much of the Russian supply has normally come through Hamburg.

Spanish ergot is usually considered more valuable than the Russian. This is mainly due to the fact that the former drug is carefully cured and preserved, whereas the Russian is frequently stored before being properly dried, and, when received in America, is frequently moldy and wormy. Because of the frequent variations and rapid deterioration of this drug under improper storage conditions, it is the general practice to buy ergot by physiological test.

Substitutes for ergot—Other ergots.—While the ergot of rye alone is official, the same fungus occurs on wheat, barley, and a large number of grasses throughout the Temperate Zone. On these the fungus produces a sclerotium similar to that on rye. Many of these ergots have been pharmacologically tested and found to be equivalent in action to ergot of rye, but they occur in such small, scattered quantities as to render their collection commercially impossible; therefore they do not occur in trade.

Drugs used for similar purposes include ustilago, cotton-root bark, tansy, pennyroyal, and aloes.

Production of ergot.—Wild ergot forms the principal commercial product. While ergot may occur wherever rye is grown, its production in quantity is characteristic of a low type of agriculture. It also varies greatly with weather conditions, being most prevalent in damp seasons.

The cultivation of ergot has been attempted in several European countries, but owing to the difficulty of successfully germinating the fungus, of accomplishing infection in quantity, and the menace of the fungus to commercial grain crops, the industry has never reached large proportions.

Ergot is separated from rye at thrashing time, preferably by hand picking from the ears, or else by sifting the thrashed grain. It should be carefully dried without the use of artificial heat, and preserved in glass or tin, and kept from insect attack by the addition of small quantities of carbon tetrachloride, or chloroform. It more frequently occurs in commerce in large sacks.

Under ordinary atmospheric conditions ergot deteriorates rapidly, especially when powdered, and formerly was considered valueless after

a year from harvest. By the use of cold storage, however, ergot can be kept in good condition a considerable length of time. Other methods of preservation, e. g., the removal of oil, stratification in sand, and preservation in chloroform, have been experimentally tried, but are not of commercial importance.

Properties and uses.—Ergot is one of the more important botanical drugs and is official in all pharmacopœias.

Ergot is ecbolic, emmenagogue, parturient, astringent, hæmostatic, excitomotor, and poisonous. It is employed in medicine mainly for the arrest of hemorrhage and the contraction of dilated blood vessels. It is of most value in the prevention and arrest of postpartum hemorrhage. In connection with bromides it has been successfully used in the treatment of certain forms of vertigo. Ergot has several other minor uses.

The American official preparations of ergot are the extract, fluid extract, aqueous extract, and the ammoniated tincture.

Competitive conditions.—Ergot occurs to a considerable extent in the fall rye crop of the northern Mississippi Valley, also more or less in wheat and the western wheat grass of the Dakota prairies. The amount in rye varies probably from one-tenth of a per cent to 5 per cent in aggravated cases. It is eradicated from the harvested and thrashed rye by blowers and screens, which take out with it rye grains, heads, and miscellaneous trash. Ergot in the screenings has been found to run as high as 19 per cent. While the ergot thus produced is probably sufficient in amount to supply the American market and, pharmacologically, seems equal or superior to the imported product, the cost of cleaning it from the waste has thus far exceeded the price of Russian or Spanish ergot. Investigations are being carried on to render this separation economically possible.

Propagation of ergot has not been tried in America, and would be highly inadvisable from the point of view of the public health because of the rapidity with which this dangerous disease spreads to the rye crop.

Importance of ergot to the rye crop.—Economically ergot is of twofold importance. Its value as a drug has been indicated. As a fungus it is the cause of a most serious disease of the rye crop, serious not alone for its destructive effect, which indeed is rather slight, but because of the dangerously poisonous nature of the substance which it adds to the harvested rye. Spores, derived from old ergot grains which have survived the winter, germinate within the developing flower of rye, and the vegetative body produced soon yields a second crop of spores which are spread by wind and insects to other blossoms. The fungus confines its attacks to the young grain, which it later replaces by a hard compact body, the sclerotium or ergot proper, which matures at the same time as the grain and somewhat resembles it in size and shape, though being frequently (especially in Spanish ergot) much larger. Usually only a few kernels of a head are attacked the other maturing normally. The ergot grain is extremely poisonous, and before its nature was recognized was frequently the cause of serious epidemics with many deaths among rye-eating peoples. Stock poisoning also has been caused by ergot. Thus the separation of ergot from rye is rendered imperative by its nature as well as prompted by its drug value.

War conditions.—In common with other European drugs, the price of ergot rose sharply after the outbreak of the war. Russian ergot

rose from 55 cents per pound in June to $2 per pound in September, and Spanish in the same period from 75 cents to $2.75. The fall of prices, however, was little less rapid; by January 1 Russian ergot sold for 92½ cents and Spanish for 90 cents, and with a single exception ($1 for Spanish in June, 1915), prices have since tended to decrease. December 31, 1917, both grades sold for 78 cents.

It is reported that the past year's (1917) production of Spanish ergot was extremely small, not over 40,000 pounds. Russian conditions may be expected to disorganize the import of ergot from that country.

Ergot—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	Free	213,589	$45,425	.....	$0.213	.....
1908	do	106,576	23,769	.....	.223	.....
1909	do	135,740	36,651	.....	.270	.....
1910	do	181,614	52,911	.....	.291	.....
1911	do	141,334	75,592	.....	.535	.....
1912	do	207,138	187,500	.....	.905	.....
1913	do	223,793	208,364	.....	.931	.....
1914	do	22,326	16,256	.....	.728	.....
	10 cents per pound	163,378	86,384	$16,337	.529	18.91
1915	do	141,915	92,459	14,191	.651	15.35
1916	do	123,015	73,896	12,301	.600	16.65
1917	do	165,701	80,647	16,570	.487	20.55
1918	do	140,474	81,267	14,047	.578	17.29
1919	do	116,813	149,890	11,681	1.283	7.79
Calendar years:						
1918	do	97,647	61,523	9,765	.630	15.87
1919	do	171,950	346,707	17,195	2.010	4.96
1920[1]	do	36,228	140,453	3,683	3.813	2.62

[1] Six months ending June 30, 1920.

Ergot—Prices per pound, wholesale, New York spot.

[From Oil, Paint, and Drug Reporter.]

	SPANISH.	RUSSIAN.	RUSSIAN—continued.
Jan. 1, 1912	$1.20–$1.25	1.20–1.25	
Apr. 1, 1912	1.10–1.15	.90–.95	
July 1, 1912	.98–1.10	.80–.85	
Sept. 30, 1912	1.50–1.60		1.00–1.10
Dec. 30, 1912	1.60–1.70		1.20–1.30
Mar. 31, 1913	1.40–1.50		1.15–1.20
June 30, 1913	1.55–1.60		.85–.90
Sept. 29, 1913	1.30–1.40		.75–.80
Dec. 29, 1913	.95–1.00		.68–.70
Mar. 30, 1914	.75–.80		.57–.58
June 29, 1914	.70–.75		.54–.55
Sept. 28, 1914	2.50–2.75		1.90–2.00
Dec. 28, 1914	.85–.90		.90–.92½
Mar. 29, 1915	.87½–.90		.87½–.90
June 28, 1915	.95–1.00		.90–.95
Sept. 27, 1915	.85–.90		.75–.80
Jan. 3, 1916	.85–.90		.75–.80
Apr. 3, 1916	.85–.90		.75–.80
July 3, 1916	.75–.80		.72½–.75
Oct. 2, 1916	.75–.80		.70–.72
Jan. 1, 1917	.68–.70		.68–.70
Apr. 2, 1917	.72		.72
July 2, 1917	.72–.75		.75
Oct. 1, 1917	.72–.73		.75
Dec. 31, 1917	.78		.78
Jan. 5, 1918	.78–.80		.78–.80
Apr. 1, 1918	.85–.90		.85–.90
July 1, 1918	1.00–1.05		1.00–1.05
Oct. 7, 1918	1.95–2.00		1.95–2.00
Jan. 6, 1919	2.50–2.55		2.50–2.55
Apr. 7, 1919	2.50–2.75		[1] 2.50–2.75 [2] 2.65–2.90
July 7, 1919			[2] 3.50
Oct. 6, 1919			[2] 4.00–4.10
January, 1920			5.00–5.25
April, 1920			5.00–5.50
July, 1920			6.50–6.60
October, 1920			3.50–3.60

[1] To arrive.

[2] Spot.

Ergot—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem
1883.....	534	Ergot.....	Free.
1890.....	563	.....do.....	Do.
1894.....	473	.....do.....	Do.
1897.....	551	.....do.....	Do.
1909.....	562	.....do.....	Do.
1913.....	28	.....do.....	10 cents per pound.

ETHERS AND ESTERS.

[Par. 29, act of 1913.]

General Information.

INTRODUCTION.

Par. 16. "* * * ethers * * * fruit essences, all the foregoing and their combinations when containing alcohol * * * if containing 20 per centum of alcohol or less, 10 cents per pound and 20 per centum ad valorem; containing more than 20 per centum and not more than 50 per centum of alcohol, 20 cents per pound and 20 per centum ad valorem; containing more than 50 per centum of alcohol, 40 cents per pound and 20 per centum ad valorem."

Par. 29. "Ethers: Sulphuric, 4 cents per pound; amyl nitrite, 20 per centum ad valorem; amyl acetate and ethyl acetate or acetic ether, 5 cents per pound; ethyl chloride, 20 per centum ad valorem; ethers and esters of all kinds not specially provided for in this section, 20 per centum ad valorem: *Provided*, That no article containing more than 10 per centum of alcohol shall be classified for duty under this paragraph."

Par. 46. "* * * and all fruit ethers * * * 20 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph."

Ether when used as a name alone without other special designation always signifies ethyl ether, diethyl oxide. It was formerly called sulphuric or phosphoric ether, depending on the acid which had been used in its preparation. Ether is also used as a class name to designate a group of organic chemical compounds, which are oxides of hydrocarbon alkyl radicals. Esters are products of the action of acids on alcohols with the elimination of water. They are analagous to inorganic salts. Many compounds which are strictly esters are often and incorrectly called ethers. This is true of ethyl nitrite (incorrectly called nitrous ether) and ethyl nitrate (incorrectly called nitric ether) and of many others which are known in chemical nomenclature as esters. Of the articles mentioned by name in paragraph 29 sulphuric ether is the only true ether. The other commodities are, strictly speaking, esters.

Fruit ethers are mixtures of various esters, usually diluted with cologne spirits (ethyl alcohol).

ETHER, SULPHURIC OR ETHYL.

Description and uses.—Ethyl ether is a colorless mobile liquid with a pleasant odor. It is very volatile and boils at 35° C. The Pharmacopœia describes ethyl ether as follows: "A liquid containing not less than 95.5 per cent nor more than 97.5 per cent of ethyl oxide

($[C_2H_5]_2O$), the remainder consisting of alcohol containing a little water." Ether is very inflammable and when mixed with air it forms an explosive mixture. There are several grades of ether quoted on the market, "washed" "U. S. P. 1880," "U. S. P. 1900," and "anesthetic." The U. S. P. 1880 and 1900 refer to the standard as given in the Pharmacopœia revision of those years.

The vapors of ether when inhaled produce anesthesia and this property is made use of in surgery. It is used to some extent as a local anesthetic, when a spray of ether is directed on the skin and the extreme cold produced by the rapid evaporation causes complete local insensibility. Technically, ether is largely used in combination with alcohol as a solvent for nitrocellulose (guncotton, collodin, pyroxylin plastics). It also dissolves other substances, such as resins, fats, waxes, and alkaloids. It is used in some formulas for denaturing alcohol.

Domestic production.—The production of ether in 1914, exclusive of that manufactured and consumed by the explosive industry, was 2,120,082 pounds, valued at $278,816. This is an increase of nearly 1,000,000 pounds over the production in 1909.

The materials necessary for the production of ether are ethyl alcohol and sulphuric acid, which are avilable in this country in large quantities.

Ether is produced by heating alcohol and sulphuric acid together at a temperature between 140° and 145° C. The ethyl alcohol and sulphuric acid at first combine to form ethyl hydrogen sulphate, which combines at once with more alcohol with the formation of ether and the regeneration of sulphuric acid. Theoretically, a limited amount of sulphuric acid is sufficient to convert an unlimited quantity of alcohol into ether. Advantage is taken of this in the commercial preparation of ether, but the formation of secondary products makes it necessary to use fresh sulphuric acid at the end of a certain time. The ether and water distill out of the reaction chamber into a condenser which is kept at a temperature just above the boiling point of ether. Here the water vapor is condensed and the ether passes on to a tower filled with charcoal saturated with caustic soda which removes any sulphur dioxide which the ether may contain. The ether is then condensed in a cold condenser and collected. The process is more or less continuous as the alcohol is added continuously to the sulphuric acid until it becomes necessary to change the acid.

The domestic production of ether supplies the consumption of this country, as the imports have been very sporadic and are entirely negligible when compared with the production.

The price of the various grades of ether has increased from 50 to 100 per cent over the price prevailing before the outbreak of war.

AMYL NITRITE.

Description and uses.—Purified amyl nitrite which is chiefly iso-amyl nitrite is a slightly yellow liquid with a penetrating apple-like odor and a pungent aromatic taste. The vapors when inhaled produce a powerful effect on the system. Iso-amyl nitrite has a specific gravity of 0.902 and boils from 94° to 95° C. The commercial product is far from pure. It is liable to contain ethyl and amyl alcohols, amyl nitrate and other organic alcohols and esters. Amyl

nitrite is very volatile, and it is practically impossible to stopper bottles so that there will be no leakage. It is used for medicinal purposes and in the preparation of artificial fruit ethers.

Domestic production.—Amyl nitrite is prepared by distilling a mixture of amyl alcohol with sodium nitrite and sulphuric acid. The amyl alcohol is obtained by the purification of fusel oil (see T. I. C. unit on Fusel Oil). The crude distillate is washed with water and a solution of soda ash, and then the oily liquid is redistilled and the fraction between 90° and 100° C. is collected as amyl nitrite.

No imports of amyl nitrite have been shown in the reports of Commerce and Navigation.

The figures on the production of amyl nitrite in this country are not available.

AMYL ACETATE.

Description and uses.—Amyl acetate is the acetic ester of amy alcohol. When pure amyl acetate is a colorless, limpid, rather agreeable smelling liquid which boils at about 139° C. It is lighter than water and is difficultly soluble in water. It dissolves freely in alcohol, ether, chloroform, and amyl alcohol.

There are two distinct grades of amyl acetate, the "purified" product, which is produced by the "cold process" and the technical product, which is manufactured by the "hot process." The purified amyl acetate is used in the preparation of fruit flavors, flavoring essences, confectionery, and soft drinks. It consists of nearly pure iso-amyl acetate. The technical acetate is the most important and is widely used as a cellulose nitrate solvent, especially in the pyroxylin lacquer industry, where its high boiling point is of great value. It contains principally iso-amyl acetate mixed with acetates of the other alcohols homologous to amyl alcohol which are present in the crude material fusel oil.

Domestic production.—The domestic production of amyl acetate in 1914 was 1,300,052 pounds, valued at $465,664. The manufacture for commercial purposes has assumed large proportions and requires considerable capital. The details of the process of manufacture require careful and close technical supervision in order to obtain the maximum yield of amyl acetate owing to the variations in the raw material (fusel oil).

The raw materials required for the manufacture of amyl acetate are fusel oil, acetic acid either as such or in the form of acetate of lime or soda, and sulphuric acid. All of these materials with the exception of fusel oil are produced in sufficient quantities in this country. The domestic production of fusel oil is not large enough to meet the demands of amyl acetate and large quantities, therefore, are imported annually chiefly from Russia, United Kingdom, and Germany. (See Survey on Fusel oil or amylic alcohol.)

The process used in the manufacture of amyl acetate depends on the use for which the product is intended. The processes used are known as the "cold process" and the "hot process."

The cold process is used when a pure amyl acetate is desired, as for use in fruit flavors and confectionery. This process is comparatively simple and involves no complicated or costly apparatus. Rectified fusel oil is placed in an open pot and the required quantity of sulphuric acid is added as a dehydrating agent to combine with

the water formed during the process. Acetic acid (80 per cent) is then run slowly into the fusel oil-sulphuric acid mixture, which is constantly agitated. Sodium acetate may be used instead of the acetic acid. In this case the sodium acetate is first placed in the open pot and the fusel oil and sulphuric acid, which have previously been mixed, added to it with constant agitation. The amyl acetate is produced at once and rises to the top of the mixture. It is separated from the mass and purified by treatment with soda ash and distillation. The yield in this process is about 85 per cent of theoretical.

The hot process is used for the production of technical amyl acetate and the quantity produced by this method is by far the greater. Crude fusel oil is mixed with sulphuric acid (63° Baumé) in an iron or lead pot and allowed to cool. Gray acetate of lime is placed in the still and the fusel oil-sulphuric acid mixture is run in all at once. The still is closed tightly, the contents are agitated slowly, and heat is applied gradually. The heat of the reaction is usually so great that little external heat is required to keep the mixture at the boiling point after the reaction has been started. The mixture is first boiled under reflux condensation for from one to three hours. The amyl acetate is then distilled over with considerable water, live steam being admitted to the still toward the end of the distillation. The amyl acetate separates from the water and is purified by redistillation. The residue in the still of calcium sulphate and dilute sulphuric acid is thrown away.

The production of amyl acetate in this country supplies the domestic consumption, as no imports of amyl acetate are shown in Commerce and Navigation.

The price of amyl acetate during the war was from two to three times as great as the prices prevailing in 1913 and 1914.

ETHYL ACETATE.

Ethyl acetate is the acetic ester of ethyl alcohol. It is a colorless, fragrant smelling liquid, soluble in 17 parts of water and freely miscible in all proportions with alcohol, acetone, ether, and amyl acetate. It boils at 77° C. Pure ethyl acetate is said to remain neutral indefinitely, but rapidly acquires an acid reaction when a small amount of water is present. For this reason it is of no value alone as a pyroxylin solvent. A mixture of 70 per cent of ethyl acetate and 30 per cent of amyl acetate or 75 per cent of ethyl acetate and 25 per cent of amyl acetate produces a solvent mixture which has a wide and satisfactory range of use. The higher boiling amyl acetate decreases the tendency of the ethyl acetate to take up water, reduces the volatility, and prevents in a great measure the development of an acid reaction on standing.

The admission of denatured alcohol (ethyl or grain alcohol), the raw material, has revived the possibility of the extensive use of ethyl acetate as a pyroxylin solvent. In speed of action ethyl acetate is superior to amyl acetate, but it tends to take up moisture from the air which precipitates the nitrocellulose in an opaque film instead of a transparent film. It is proposed to use fusel oil as the denaturant. Five to ten per cent of fusel oil effectively destroys the potability and in addition furnishes the readily detected and obnoxious odor.

Fusel oil also results in the production of a small amount of amyl acetate in the ethyl acetate, which, as pointed out, increases the value of ethyl acetate as a pyroxylin solvent.

In the pure state ethyl acetate finds extensive use in the artificial fruit essence industries and is known as acetic ether.

The manufacture of ethyl acetate is very similar to the production of amyl acetate described above, so that a detailed description is not necessary. The materials used are ethyl or grain alcohol, acetate of lime or soda, and sulphuric acid, all of which are produced in this country in sufficient quantity. Owing to the lower boiling point and greater volatility of ethyl acetate, even greater care must be exercised in its manufacture than in the production of amyl acetate.

ETHYL CHLORIDE.

Description and uses.—Ethyl chloride is the hydrochloric ester of ethyl alcohol. It is known by many pharmaceutical names, such as æthylum chloratus, æther chloratus, æthylis chloridum, æther hydrochloricus, hydrochloric ether, chlorhydric ether, and chlorathyl. It is used as an anesthetic, especially for local anesthesia. For this purpose on account of its low boiling point (12° to 15° C.) it is put up in sealed or mechanically capped glass or metal tubes of convenient forms, wherein it is held under pressure. Automatic closing tubes are preferable for anesthesia, and there are several different types on the market, each manufacturer using his own special form. At temperatures below its boiling point or when under pressure as in the above containers it is a colorless, mobile, very volatile liquid having a characteristic ethereal odor and a burning taste. On account of its great volatility ethyl chloride is sometimes mixed with an equal volume of ethyl alcohol. This mixture is known as "alcoholized muriatic ether."

For anesthetic purposes ethyl chloride must be exceptionally pure and should not contain water, foreign chlorides, acids, aldehydes, ether, alcohol, and organic metallic substances. Ethyl chloride has not been used industrially although its advantages as refrigerating agent have been pointed out.

Domestic production.—Figures on the domestic production of ethyl chloride are not available.

Ethyl chloride is usually prepared from ethyl alcohol as the basic raw material. It may also be prepared from ethane or from ordinary ether. Hydrochloric acid or chlorine gas are the other materials required for the preparation of ethyl chloride from any of the above materials.

Ethyl chloride is generally prepared by treating ethyl alcohol with hydrochloric acid gas in the presence of a dehydrating agent, such as anhydrous zinc chloride or phosphorus pentoxide. One part of zinc chloride is mixed with 80 parts of ethyl alcohol and the mixture is then saturated with hydrochloric acid gas in the cold. The mixture is then heated to boiling and hydrochloric acid gas passed into the mixture during the distillation. A reflux condenser prevents the alcohol from distilling out of the vessel but allows the ethyl chloride as it is formed to pass into a refrigerated container where it condenses. Ethyl chloride is purified by passing the vapors through water, then

dilute caustic soda, and finally through concentrated sulphuric acid. This treatment removes alcohol, hydrochloric acid, and water.

Ethyl chloride may be obtained from alcohol by treatment with phosphorus pentachloride or sulphur monochloride. It is also formed by the action of chlorine on ethane and by the action of hydrochloric acid on ether in sealed tubes.

In the manufacture of ethyl chloride it is advisable to use very pure alcohol and hydrochloric acid as there will then be no danger of the product containing impurities. If denatured alcohol is used, impurities are introduced which must be removed by the process of purification. The use of animal oil, pyridin bases, pyridin bases and benzol, or methyl alcohol and zinc chloride as denaturants are permitted in the preparation of ethyl chloride from alcohol. The use of these denaturants are in accordance with the Bureau of Internal Revenue Regulations No. 30, formulas 6–b, 8, 14, and 17.

The imports of ethyl chloride prior to the war averaged about 8,000 pounds per year. The import in 1917 was about 9,000 pounds, but during the other war years the import declined considerably below the average. (P. 9.)

FRUIT ETHERS.

Many fruits owe their flavor to mixtures of various esters. It has become common practice to use mixtures of organic esters to imitate fruit flavors. These fruit ethers are largely used in soft drinks and confectionery. They usually contain as the base material ethyl alcohol (cologne spirits). About 85 to 90 per cent of the fruit ether is alcohol and the remainder is a mixture of various synthetic esters and in some cases they contain other organic substances.

There are three possible classifications of fruit ethers under the act of 1913, depending on the alcohol content of the ether. Fruit ethers are mentioned by name in paragraph 46 along with various essential and distilled oils, followed by the provision "that no article containing alcohol shall be classified in this paragraph." The only fruit ethers which could come within this provision would be mixtures of various esters with the alcohol omitted. These mixtures could be imported and then diluted with alcohol, thus producing the product which is commercially known as fruit ethers. If a fruit ether was imported containing less than 10 per cent of alcohol, it would probably be classified under paragraph 29. The rate of duty on fruit ethers in paragraph 46 and for all other ethers in paragraph 29 is the same (20 per cent ad valorem). On the other hand, if what are usually known as fruit ethers were imported, they would be necessarily dutiable under paragraph 16 in view of their alcoholic content. The duty then would be 10 cents per pound and 20 per cent ad valorem, 20 cents per pound and 20 per cent ad valorem, or 40 cents per pound and 20 per cent ad valorem, depending on the alcohol content.

It seems that the provision for fruit ethers in paragraph 46 is out of place. Fruit ethers are very dissimilar from essential or distilled oils. If this provision was eliminated, fruit ethers would then be classified in paragraph 16 or 29, depending on their alcohol content.

Production of sulphuric ether in United States.[1]

[Figures from "Federal Census."]

Year.	Quantity.	Value.
	Pounds.	
1899	263,238	$129,876
1904	854,411	427,401
1909	1,168,631	190,164
1914	2,120,082	278,816

[1] Does not include the ether manufactured and consumed by the explosive industry.

Ethers, sulphuric—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	40 cents per pound	2,435	$372	$974	$0.153	262.10
1908	do	2,948	526	1,179	.178	224.22
1909	do	1,234	221	493	.180	222.52
1910	do	50	9	20	.180	222.22
1910	8 cents per pound	287	66	22	.230	34.79
1911	do	1,475	289	118	.196	40.84
1912	do	1,434	207	114	.144	55.44
1913	do	755	120	60	.159	50.33
1914	do	580	83	46	.143	55.90
1914	4 cents per pound	335	48	13	.143	27.92
1915	do	849	189	33	.223	17.96
1916	do	62	23	2	.371	10.78
1918	do	8	7	.....	.875	.....
1919	do	282,576	28,258	11,303	.100	40.00
Calendar years:						
1918	do	8	7	.....	.863	.....
1919	do	282,576	28,258	11,303	.10	40.00
1920[1]	do	100	34	4	.34	11.76

[1] 6 months.

Ethers, ethyl chloride—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1910	30 per cent	5,183	$4,887.00	$1,466.00	$0.84	30.00
1911	do	7,024	8,396.00	2,518.00	1.20	30.00
1912	do	8,372	5,187.00	1,556.00	.62	30.00
1913	do	11,240	7,903.00	2,370.00	.70	30.00
1914	do	500	964.00	289.00	1.93	30.00
1914	20 per cent	8,514	9,082.00	1,816.00	1.07	20.00
1916	do	2,780	5,193.00	1,038.00	1.87	20.00
1917	do	8,917	5,207.00	1,041.00	.57	20.00
1918	do	1,274	2,411.00	482.00	1.89	20.00
1919	do	22,495	2,250.00	450.00	.10	20.00
Calendar years:						
1919	do	22,495	2,250.00	450.00	.10	20.00
1920[1]	do	877	685.00	137.00	.781	20.00

[1] 6 months.

Ethers, amyl nitrate—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year		*Pounds.*				*Per cent.*
1915	20 per cent	4,067	$4,444.00	$889.00	$1.093	20.00

Ethers, amyl acetate and ethyl acetate or acetic ether—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914	5 cents per pound	110	$20.00	$5.00	$0.182	27.50
1919	do	80	39.00	4.00	.487	10.26
Calendar years:						
1918	do	80	39.00	4.00	.487	10.26
1920 [1]		400	493.00	20.00	1.232	4.06

[1] 6 months.

Other ethers and esters n. s. p. f.—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1910 [1]	50 cents per pound	190	$223.00	$95.00	$1.17	42.60
1910	All those specific duty less than 25 per cent.	.....	3,656.00	914.00	.....	25.00
1911	50 cents per pound	130	108.00	65.00	.846	60.19
1911	All those specific duty amounted to less than 25 per cent.	.....	8,451.00	2,113.00	.....	25.00
1912	50 cents per pound	239	127.00	119.50	.533	93.80
1912	All those specific duty amounted to less than 25 per cent.	1,369	5,589.00	1,397.00	4.08	25.00
1913	50 cents per pound	475	296.00	237.00	.623	80.20
1913	D. R. U. S.	33	7.00	.....	.212	.....
1913	All those specific duty amounted to less than 25 per cent.	1,645	7,029.00	1,757.00	4.27	25.00
1914 [2]	50 cents per pound	76	89.00	38.00	1.17	42.70
1914 [3]	20 per cent ad valorem	11,960	4,960.00	992.00	.415	20.00
1914	All those specific duty amounted to less than 25 per cent.	387	1,845.00	461.00	4.77	25.00
1914	Containing more than 20 per cent and less than 50 per cent alcohol, 20 cents plus 20 per cent.	2	3.00	1.00	1.50	33.33
1915	20 per cent ad valorem	6,301	4,500.00	900.00	.714	20.00
1915	More than 10 per cent and less than 20 per cent alcohol, 10 cents plus 20 per cent.	66	64.00	19.00	.969	30.31
1916	20 per cent ad valorem	598	1,410.00	282.00	2.36	20.00
1916	More than 20 per cent and not more than 50 per cent alcohol, 20 cents and 20 per cent.	79	93.00	34.40	1.18	36.99
1916	More than 50 per cent alcohol, 40 cents per pound and 20 per cent.	61	76.00	39.60	1.25	52.11
1917	20 per cent ad valorem	25	63.00	12.60	2.52	20.00
1918	More than 50 per cent alcohol, 40 cents per pound and 20 per cent.	880	182.00	388.00	.207	213.41
1919	20 per cent	22,806	2,574.00	514.80	.112	20.00
Calendar years:						
1918	do	120	210.00	42.00	1.75	20.00
1919	do	22,796	2,464.00	492.80	.108	20.00
1920 [4]	do	89	302.00	60.12	3.393	20.00

[1] From Aug. 6, 1909, to June 30, 1910.
[2] From July 1 to Oct. 3, 1913.
[3] From Oct. 4, 1913, to June 30, 1914.
[4] 6 months.

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Amyl acetate—Prices per gallon.

[From Oil, Paint, and Drug Reporter.]

1912.	
January	$3.00–$3.25
April	2.90– 3.00
July	2.90– 3.10
October	2.75– 3.50
1913.	
January	2.65– 3.00
April	2.35– 2.50
July	2.20– 2.25
October	2.20– 2.25
1914.	
January	1.80– 1.90
April	1.60– 1.65
July	1.55– 1.60
October	2.25– 2.50
1915.	
January	2.50– 2.60
April	2.65
July	2.50– 2.75
October	3.00
1916.	
January	4.50– 5.50
April	4.75– 5.00
July	5.50
October	4.75– 4.85
1917.	
January	4.50– 4.75
April	4.75– 5.00
July	5.00– 5.25
October	5.00– 5.25
1918.	
January	5.25– 5.35
April	5.50– 5.70
July	5.15– 5.20
October	5.30– 5.35
1919.	
January	3.75– 4.00
April	3.75– 4.00
July	3.60– 3.65
October	3.65– 3.70
1920.	
January	3.65– 3.70
April	4.10– 4.25
July	4.70– 4.80
October	4.10– 4.15

Ether, acetic or ethyl acetate—Prices per pound.[1]

[From Oil, Paint, and Drug Reporter.]

	Acetic, 95 p. c. carboys.	*U. S. P. 8th and 7th.*
1916.		
January	$0.19	$0.50–$0.62
April	.19	.50– .62
July	.19	.50– .62
October	.19	.50– .62
1917.		
January	.19	.50– .62
April	.19	.50– .62
July	.52½	.85– .90
October	.52½	.85– .90
1918.		
January	$0.83– .85	1.50– 1.55
April	.83– .85	1.50– 1.55
July	.83– .85	1.50– 1.55
October	.83– .85	1.50– 1.55
1919.		
January	.83– .85	1.50– 1.55
April	.83– .85	1.50– 1.55
July	.80–1.50	.80– 1.50
October	.80–1.00	.80– 1.05
1920.		
January	.80–1.00	.80– 1.00
April	1.20–1.30	1.20– 1.30
July	1.25–1.30	1.25– 1.30
October		1.25– 1.30

[1]Not quoted prior to 1916. Prices quoted after July, 1919, are of ethyl acetate, commercial, per gallon

Sulphuric ether—Prices per pound.

[From Oil, Paint, and Drug Reporter.]

Kinds or grades.	1912	1913	1914	1915	1916	1917	1918	1919	1920
U. S. P. 1880:									
January	22–28	22–28	22–28	22–28	22–28	22–28	27	24–25	34
April	22–28	22–28	22–28	22–28	22–28	22–28	35–36	22–24	37
July	22–28	22–28	22–28	22–28	22–28	27–32	27–28	34	46–47
October	22–28	22–28	22–28	22–28	22–28	35–40	24–25	34	46–47
U. S. P. 1900:									
January	14–20	14–20	14–20	15–20	15–20	15–20	27	28–29	.....
April	14–20	14–20	18–24	15–20	15–20	23–30	27	23–24	.....
July	14–20	14–20	18–24	15–20	15–20	31–39	27	.....	.....
October	14–20	14–20	18–24	15–20	15–20	31–39	28–29	.....	.....
Washed:									
January	18–27	18–27	18–27	18–27	18–27	18–27	32	32–33	26
April	18–27	18–27	18–27	18–27	18–27	18–27	32	27–28	30
July	18–27	18–27	18–27	18–27	18–27	23–30	35	26	39–40
October	18–27	18–27	18–27	18–27	18–27	31–39	32–33	26	39–40

Esters and ether—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	106	Ether, sulphuric, per pound	50 cents.
	110	Ether, nitrous, spirits of, per pound	30 cents.
	113	Oil of cognac, or oenantic ether, per ounce	$4.
	114	Fruit ethers, * * * per pound	$2.50.
	116	Ethers of all kinds, not specially enumerated or provided for in this act, per pound.	$1.
	118	Preparations: All medicinal preparations known as * * * ethers, * * * of which alcohol is a component part, not specially enumerated or provided for in this act, per pound.	50 cents.
1890	[1] 25	Ethers, sulphuric, per pound	40 cents.
		Spirits of nitrous ether, per pound	25 cents.
		Fruit ethers, oils or essences, per pound	$2.50.
		Ethers of all kinds not specially provided for in this act, per pound.	$1.
1894	[1] 17	Ethers, sulphuric, per pound	40 cents.
		Spirits of nitrous ether, per pound	25 cents.
		Fruit ethers, oils or essences, per pound	$2.
		Ether of all kinds not specially provided for in this act, per pound.	$1.
1897	[1] 21	Ether, sulphuric, per pound	40 cents.
		Spirits of nitrous ether, per pound	25 cents.
		Fruit ethers, oils, or essences, per pound	$2.
		Ethers of all kinds not specially provided for in this act, per pound.	$1.
		Provided, That no article of this paragraph shall pay a less rate of duty than.	25 per cent ad valorem.
1909	[1] 21	Ethers, sulphuric, per pound	8 cents.
		Spirits of nitrous ether, per pound	20 cents.
		Fruit ethers, oils, or essences, per pound	$1.
		Ethers of all kinds not specially provided for in this section, per pound.	50 cents.
		Ethyl chloride	30 per cent ad valorem.
		Provided, That no article of this paragraph shall pay a less rate of duty than.	25 per cent ad valorem.
1913	16	Chemical and medicinal compounds and preparations, including * * * ethers, * * * all the foregoing and their combinations when containing alcohol * * * and all alcoholic compounds not specially provided for in this section, if containing 20 per centum of alcohol or less, per pound.	10 cents and 20 per cent ad valorem.
		Containing more than 20 per centum and not more than 50 per centum of alcohol, per pound.	20 cents and 20 per cent ad valorem.
		Containing more than 50 per centum of alcohol, per pound	40 cents and 20 per cent ad valorem.
	17	Chemical and medicinal compounds, combinations and all similar articles dutiable under this section * * * put up in individual packages of 2½ pounds or less gross weight (except samples without commercial value) shall be dutiable at a rate not less than.	20 per cent ad valorem.
		Provided, That chemicals, drugs, medicinal and similar substances, whether dutiable or free, imported in capsules, pills, tablets, lozenges, troches, ampoules, jubes, or similar forms, shall be dutiable at not less than.	25 per cent ad valorem.
	29	Ethers, sulphuric, per pound	4 cents
		Amyl nitrite	20 per cent ad valorem.
		Amyl acetate and ethyl acetate or acetic ether, per pound	5 cents.
		Ethyl chloride	20 per cent ad valorem.
		Ethers and esters of all kinds not specially provided for in this section.	20 per cent ad valorem.
		Provided, That no article containing more than 10 per centum of alcohol shall be classified for duty under this paragraph.	
	46	* * * and all fruit ethers, oils, and essences * * * not specially provided for in this section.	20 per cent ad valorem.
		Provided, That no article containing alcohol shall be classified for duty under this paragraph.	

[1] When containing alcohol, as alcoholic or chemical compounds.

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COURT AND TREASURY DECISIONS.

The following have been held to be fruit ethers:

Pure amyl acetate.—T. D. 8881; G. A. 5712 (T. D. 25404); Abstract 33067 (T. D. 33644).

Oenanthic ether, also known as pelargonate of ethyl or pelargonic ether.—G. A. 3597 (T. D. 17406).

Valerianic ether, or amyl valerianate.—T. D. 8881; T. D. 9205; G. A. 1939 (T. D. 13701).

Batyric ether.—G. A. 2332 (T. D. 14521).

The weight of the expert evidence in a case upon enquinine was that an ester is not a salt, but is what English chemists call a compound ether.—United States *v.* Merck, 168 Fed. 244.

The following have been held not to be fruit ethers:

Acetic ether.—G. A. 1683 (T. D. 13303).

Heavy oil of wine.—G. A. 1800 (T. D. 13495).

Sinalco Seele, 17.6 per cent alcohol, 1.7 per cent extract with a fruit aroma, and water.—United States *v.* Chattanooga Brewing Co., 3 Ct. Cust. Appls. 375 (T. D. 32965; G. A. 7335 (T. D. 32313).

Ethyl chloride, with traces of essential oil or perfumes, was held dutiable as ethyl chloride under the acts of 1909 and 1913.—G. A. 7658 (T. D. 35026); United States *v.* Baiz, 5 Ct. Cust. Appls. 319 (T. D. 34526); Abstracts 31545 (T. D. 33263), 31589 (T. D. 33263), 34182 (T. D. 33963), and 41788.

Merchandise having characteristics of ether or ethyl chloride, in which small percentages of menthol oil, sinapis (oil of mustard), cocoaine, eucaine, iodine, ichthyol, and kelene were dissolved, was held dutiable as classified at 25 per cent ad valorem under the proviso in paragraph 21 of the act of 1897 as greater than $1 per pound under the provision in that paragraph for "ether of all kinds not specially provided for." Autosprays were dutiable at the ad valorem rates to which their contents were subjected, or exempt from duty where the contents were subjected to a specific rate and not dutiable as unusual coverings under the act of 1897.—G. A. 4874 (T. D. 22841). Hempstead *v.* United States, 96 Fed. 94 (T. D. 21972), upon glass coverings containing ethyl chloride was followed.

Ethyl chloride was held dutiable as an ether under paragraph 25 of the act of 1890 and not as a medicinal preparation containing alcohol.—G. A. 1438 (T. D. 12842).

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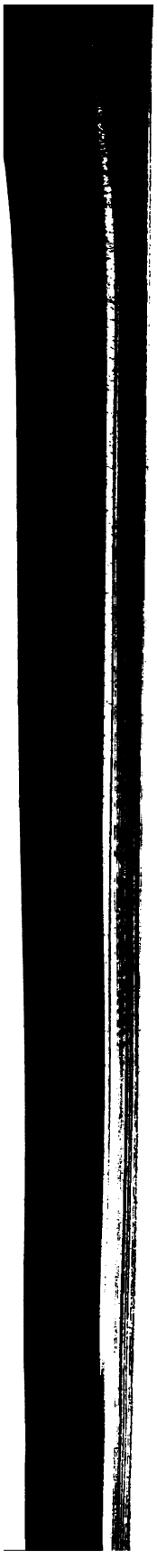

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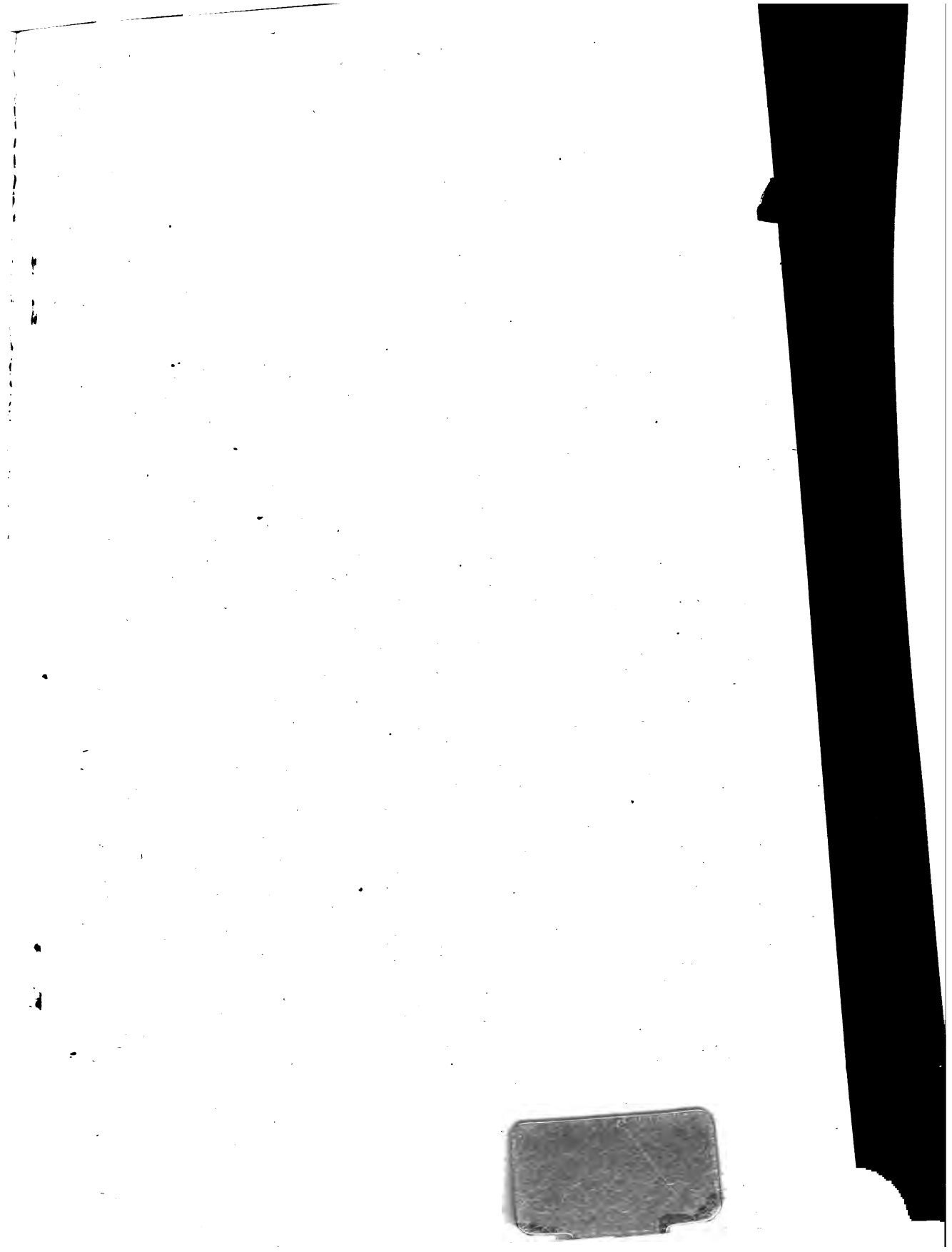

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPH 10 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS.

BARYTES, BARIUM CHEMICALS, AND LITHOPONE

Paragraph 10:
Barium Carbonate
Barium Chloride
Barium Dioxide

Paragraph 51:
Crude Barytes
Ground Barytes
Blanc Fixe

Paragraph 60:
Lithopone or White Sulphide of Zinc

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PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.

2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.

3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus by use of this "Introduction and Index," the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of C. R. DeLong, of the chemical division of the commission's staff, of George P. Comer and E. M. Whitcomb, of the accounting division, and of others.

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SUMMARY OF THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES

SUMMARY OF THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES.

The articles discussed in this report are provided for as follows in the tariff act of October 3, 1913:

10. Barium, chloride of, ¼ cent per pound; dioxide of, 1½ cents per pound; carbonate of, precipitated, 15 per centum ad valorem.

51. Baryta, sulphate of, or barytes, including barytes earth, unmanufactured, 15 per centum ad valorem; manufactured, 20 per centum ad valorem; blanc-fixe, or artificial sulphate of barytes, * * * 20 per centum ad valorem.

61. * * * lithopone and white sulphide of zinc, 15 per centum ad valorem.

BARYTES.

The source of barium is the naturally occurring minerals—barytes (barium sulphate) and witherite (barium carbonate). Metallic barium is, at present, of no industrial importance. The barium compounds manufactured from these minerals, by chemical processes, constitute an important class of commercial articles. Barytes, the more widely distributed ore, is the one generally used. England and Germany possess, in addition to barytes, deposits of witherite, which can be mined economically, and a small portion of the demand is supplied by this mineral. Barytes, on account of its whiteness, high specific gravity, and chemical inertness, is used in the ground form chiefly as a filler in paints, paper, linoleum, and rubber goods. Its use as a raw material in the manufacture of the pigment, lithopone, and the various barium chemicals is important. In 1917, with a maximum consumption of barytes, about 43 per cent was used in the manufacture of lithopone, 25 per cent in barium chemicals, and the remainder in ground barytes. Witherite is used chiefly as a filler in rubber goods and in the manufacture of barium chemicals.

Prior to the war the domestic barytes industry supplied from 55 to 65 per cent of the consumption (80,000 tons in 1913) of crude barytes in the United States. Lithopone was then the only product manufactured in this country on a large scale from crude barytes by chemical processes, and the barytes necessary for its production was imported, chiefly from Germany. Before the war Germany was the largest producer of barytes, with an output of about 300,000

short tons a year. Great Britain ranked second and the United States third. The domestic production of crude barytes, under war conditions, increased fourfold, from about 50,000 tons in 1914 to over 200,000 tons in both 1916 and 1917. The production of the United States is now second only to Germany's prewar output. The production of crude barytes in this country during the war was sufficient to meet domestic requirements.

The domestic industry prior to the war was localized; about 65 per cent of the output of crude barytes was mined in Missouri and supplied mid-western manufacturers of ground barytes. During the war the increased domestic demand was met largely by the development of southern deposits of barytes in Georgia, Tennessee, and Kentucky, and by a doubling of production in Missouri. The greatest (State) production shifted from Missouri to Georgia in 1916. Since 1915 Georgia has supplied about 50 per cent of the total domestic output. The industry as it now exists is in two distinct localities—(1) the middle western district, represented chiefly by Missouri, and (2) the southern district, represented chiefly by Georgia, Tennessee, and Kentucky. In addition to these two producing localities, there are two principal markets for crude barytes—the Atlantic coast market (from Baltimore to New York) and the middle western market (St. Louis and Chicago). The western producers and consumers are little affected by a tariff on *crude* barytes. On the other hand, eastern consumers of barytes before the war secured their supplies chiefly from Germany. Since the cessation of imports the Atlantic coast market has been supplied with crude barytes from the southern producing district, because of the differential in freight rates of $1.24 a short ton (May 29, 1920) in favor of this district over the middle western district. This localization of the industry complicates the tariff problems.

Prior to the war domestic ground barytes produced in the middle western district was able to compete in the Atlantic coast market with imported ground barytes under the duty of $5.25 per ton (act of 1909). At that time foreign competition was chiefly in the crude grade, imports of ground barytes being only about 15 per cent of the imports of the crude. During the war middle western ground barytes continued to supply a large part of the Atlantic coast market, notwithstanding the advantage of the southern district in freight rates. This may be accounted for by the fact that the middle western ore is a softer variety and grinds easier, and by the circumstance that the southern deposits were developed primarily to supply the raw material requirements of the eastern lithopone and barium chemical manufacturers. The producers in the southern district are therefore particularly interested in maintaining the eastern market for crude barytes, while the middle western producers are more in-

terested in retaining this same market for ground barytes. The situation in regard to an outlet for middle western crude barytes has been improved during the war by the establishment in the Middle West of lithopone plants, which require crude barytes as their raw material.

The extent and availability of deposits in the United States are important factors in connection with the tariff. Unfortunately, little definite, official information is available, and owing to the general nature of deposits it would be practically impossible to arrive at an accurate estimate of the total domestic resources. Under the stimulus of war conditions the domestic production supplied the entire domestic consumption. The possibility of increasing the present output of barytes appears to be most promising in the Georgia and Tennessee districts. These districts seem to contain large quantities of ore and could probably be developed to meet an increased demand of eastern manufacturers. In these districts, however, geological and geographical disadvantages will probably hinder domestic barytes from competing on even terms in the Atlantic coast market with crude barytes imported from Germany.

BARIUM CHEMICALS.

The barium chemicals discussed in this report include the barium salts mentioned in paragraph 10, and blanc fixe in paragraph 51, of the act of 1913, as well as other barium salts not mentioned specifically in the tariff. These chemicals, which are made either from barytes or witherite, have important industrial uses. The most important are as follows: *blanc fixe*, or precipitated barium sulphate (which is practically identical with ground barytes in chemical composition, but different in physical properties), used as an inert filler or pigment where a pure white product is necessary; *barium carbonate*, used chiefly in ceramics in the manufacture of enamel ware and some kinds of optical glass; *barium chloride*, used principally in the manufacture of blanc fixe and color lakes; and *barium dioxide*, used as the raw material for the production of hydrogen peroxide.

Prior to the war the United States was wholly dependent on imports for its supply of barium chemicals. Germany was the largest producer and furnished about two-thirds of the domestic requirements. About 90 per cent of the imports in 1914 were represented by three barium salts—barium carbonate, barium chloride, and barium dioxide. The cessation of imports and the war demand for barium chemicals (barium nitrate, blanc fixe, and barium dioxide) resulted in the establishment of an industry in this country. Domestic plants have been located chiefly in the East and Southeast, although there

are also plants in Ohio and Illinois. In some cases the plants have been located in close proximity to the domestic deposits of barytes. The output of barium chemicals has increased steadily each year from about 17,000,000 pounds in 1915 to over 46,000,000 pounds in 1918. The principal salts produced are blanc fixe, barium carbonate, and barium chloride, in the order of production in 1918. The domestic production of 46,000,000 pounds in 1918 may be compared with an importation in 1914 of 19,000,000 pounds in order to show the increased consumption of barium chemicals in the United States.

The chief markets for barium chemicals are in the East, and with normal conditions restored, the industry will be subjected to competition in these markets from imported barium chemicals. Eastern plants are so situated that they can use either imported or domestic barytes as the raw material. Those plants located close to the southern barytes deposits and in the Middle West will depend largely on domestic barytes. It is evident that a duty on barium chemicals should be considered in conjunction with a duty on the raw material, barytes.

LITHOPONE.

Lithopone, a white pigment, is a mixture consisting of about 70 per cent of barium sulphate and about 30 per cent of zinc sulphide. When first introduced, lithopone was known as "white sulphide of zinc," but this term, although retained in the tariff of 1913, is no longer in general use. Lithopone is used extensively in flat and enamel wall paints and as an inert filler in rubber goods, paper, linoleum, oilcloth, and window-shade cloth.

The raw materials for the manufacture of lithopone include barytes, coal or coke, zinc, and sulphuric acid. Prior to the war the entire lithopone industry was located along the Atlantic coast at or within a short distance of tidewater. The barytes requirements of the industry were supplied by imports, chiefly from Germany, at a cost less than the price at which domestic barytes could be purchased. War conditions forced lithopone manufacturers to develop southern deposits of barytes in order to have a supply of raw material. At the same time the manufacture of lithopone was started in the Middle West, thereby utilizing locally available crude barytes. An adequate supply of barytes is essential to the lithopone industry and should be given attention in considering duties on crude barytes and lithopone.

From 1910 to 1919 the domestic production of lithopone increased nearly sixfold, or from 25,000,000 pounds to about 145,000,000 pounds. The output during this period supplied from 84 to 100 per cent of the domestic consumption. On a basis of the 1919 production, about 80 per cent of the lithopone is produced in the Atlantic

coast district. The imports of lithopone have been small; the maximum importation was 7,500,000 pounds in 1914, compared with a domestic production the same year of about 65,600,000 pounds. Although there has been no official report of exports, it is known that a considerable export trade in lithopone has been developed during 1920.

Since barytes is one of their raw materials, lithopone manufacturers are naturally interested in obtaining a supply at the lowest possible cost, and they generally favor a low duty on crude barytes. Barytes enters into the cost of lithopone to the extent of about 14 per cent of the total factory cost, as shown under the cost of production on page 87. The effect of an increase or decrease in the cost of barytes, due to tariff influences or other causes, on the total cost of lithopone can, therefore, be calculated. Theoretically, any duty on lithopone should be compensatory of the duty on crude barytes to the extent revealed by the percentage of total cost given above. There are other factors entering into a consideration of the bearing of the tariff on lithopone, such as the competition between lithopone and other paint pigments.

THE BARYTES INDUSTRY

THE BARYTES INDUSTRY.

DESCRIPTION AND USES.

Barium occurs in nature as the minerals—barytes (barium sulphate) and witherite (barium carbonate). The chemical compounds manufactured from these raw materials constitute an important class of commercial articles. Barytes is the more widely distributed ore and is the one generally used in the United States. The United Kingdom and Germany also possess witherite deposits which are used in the manufacture of barium chemicals. Barytes, also known as "barite," "heavy spar," and "tiff," is composed chiefly of barium sulphate ($BaSO_4$). When pure it consists of 65.7 per cent of barium oxide (BaO) and 34.3 per cent of sulphur trioxide (SO_3). It is usually a white, opaque or translucent mineral, but it is also found stained pink or brown owing to the presence of oxides of iron. The commercial grades of crude barytes contain from 90 to 95 per cent of barium sulphate. Crude barytes is graded according to the amount and kinds of impurities which it contains; particular attention is paid to the content of iron, lead, zinc, and silica. In trade two types of crude barytes are recognized, the "hard crystalline" variety and the "soft" variety. The former has a glassy appearance and can not be broken in the hand, while the soft variety has a milky appearance and can be easily crumbled. The soft type is preferred by the grinders, as it gives the highest grade of ground barytes because of its texture and because the impurities are such that they can be dissolved and eliminated by an acid bath. This grade is not so hard on the grinding machinery and is said to roast better than the hard variety. The hard variety can be used to better advantage in the lithopone and barium chemical industries than in the manufacture of ground barytes. Both the hard and soft barytes are found in this country. That found in Missouri is a soft friable ore. The barytes found in the Cartersville (Ga.) district is a hard crystalline ore. Both types are found in the Sweetwater (Tenn.) fields, the soft ore approaching the Missouri ore and the hard ore closely resembling the Cartersville ore.

The commercial uses of barytes, as such, are largely dependent on the fact that it is a heavy, white mineral, chemically inert, and comparatively cheap. The market price of crude barytes depends to a

large extent on the ease with which it can be ground, and that of ground barytes depends on color, fineness of grinding, and to some extent on its chemical purity.

Barytes as it enters commerce may be distinguished as follows:

1. Crude barytes, barytes ore, or "tiff," as it is known locally in Missouri, is the natural mineral in the condition in which it is mined, or after it has been washed and jigged to remove earthy and mineral impurities. This grade of barytes is used as the raw material for the manufacture of ground barytes, barium chemicals, and lithopone.

2. Ground barytes is the crude ore which has been washed, jigged, and ground very fine. If the natural mineral is of the desired degree of whiteness, which is rarely the case in this country, it receives no further treatment than grinding. Ground barytes which is not pure white may be sold as ground barytes "off color" or "unbleached." This grade is used for dark-colored paints and as a filler by the paper industry, chiefly in the manufacture of heavy, stiff materials such as playing cards and Bristol boards. Ground barytes which is not pure white in color may be bleached by means of sulphuric acid which dissolves and removes the iron. This grade of ground barytes is known as "prime white" or "floated" barytes. It is used as a pigment in white paints and as a filler in paper, rubber goods, "artificial ivory," and for other purposes where a white, inert pigment or filler is desired.

Blanc fixe is precipitated barium sulphate produced by treating a solution of a barium salt with sodium sulphate (salt cake). This product, while having the same chemical composition, is different in physical properties from ground barytes. It is essentially a manufactured product and is therefore discussed under the barium chemical industry. (See p. 41.)

Barytes is the only domestic source of barium products. There is, however, a small quantity of witherite imported, which is used in the manufacture of barium chemicals. Witherite is a naturally occurring mineral composed chiefly of barium carbonate ($BaCO_3$). When pure it contains 77.6 per cent of barium oxide. Witherite has about the same hardness and specific gravity as barytes. It is easily decomposed by acids, which fact gives it advantages over barytes in the manufacture of certain barium chemicals. It is also used as an inert filler in the rubber industry. In England it is reported to be used chiefly for manufacturing barium chemicals, and it is also used in Germany for this purpose.

Table 1 shows the distribution of crude barytes according to the three principal consuming industries—ground barytes, lithopone, and barium chemicals. The total in this table does not necessarily correspond with the total production as some minor uses are not included and discrepancies may also be accounted for by

stocks in manufacturers' hands. The decrease in the consumption of crude barytes in 1918 is accounted for chiefly by a decrease in the quantity of crude barytes consumed in the manufacture of barium chemicals.

TABLE 1.—*Crude barytes used in the manufacture of barium products.*

[From Mineral Resources, U. S. Geological Survey.]

Calendar year.	For barium chemicals.	For ground barytes.	For lithopone.	Total.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
1915	10,216	53,903	44,503	108,622
1916	38,283	75,507	71,898	185,688
1917	49,842	60,132	86,065	196,039
1918	38,041	60,460	85,282	183,783
1919[1]	27,696	63,051	103,968	194,715

[1] Preliminary figures furnished by courtesy of the U. S. Geological Survey, subject to revision.

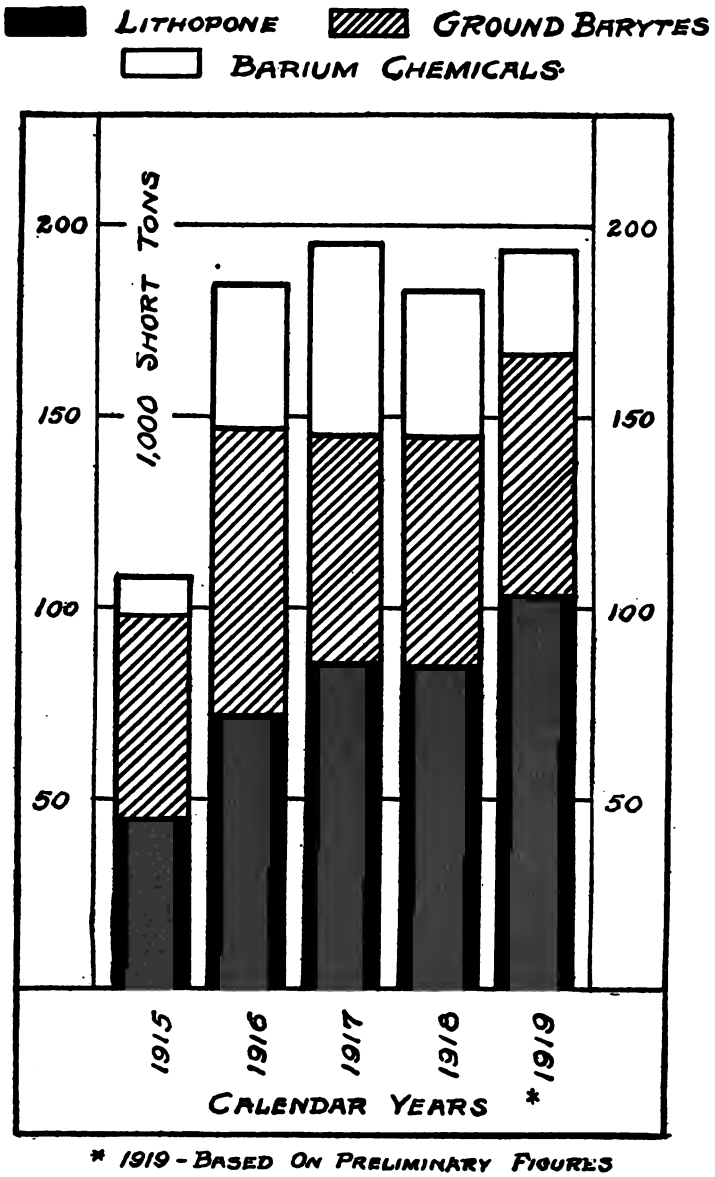
As can be seen from Table 1, the manufacture of lithopone and barium chemicals is an important outlet for crude barytes. In 1917, with a maximum consumption of crude barytes, the lithopone industry required about 43 per cent and the barium chemical industry about 25 per cent of the total quantity of crude barytes consumed in the United States. Figure 1 shows graphically the consumption of crude barytes by industries.

DOMESTIC PRODUCTION.

Production and consumption.—From 35 to 45 per cent of the domestic consumption of crude barytes prior to 1914 was imported chiefly from Germany. The imported product supplied the Atlantic coast market as it could be obtained at a cost less than that of domestic crude barytes. Prior to the war about 65 per cent of the domestic output of crude barytes was from Missouri and supplied the mid-western market for ground barytes. It has been estimated that about 50 per cent of the ground barytes manufactured in the mid-western district was prior to the war, and still is, shipped to and consumed in the Atlantic coast market. Foreign competition before the war was chiefly in crude barytes; this is evident from import statistics, which show an importation of only about one-seventh as much ground or manufactured as of crude barytes.

The great increase in the domestic production of crude barytes, beginning in the year 1915, was due partly to the cutting off of the foreign supply of barytes and barium chemicals. War conditions forced eastern manufacturers in the United States to seek a domestic supply of their raw material, and resulted in the establishment in this country of a barium chemical industry. There was also, how-

FIGURE 1 — DOMESTIC CONSUMPTION OF BARYTES BY INDUSTRIES
1915–1919



* 1919 - BASED ON PRELIMINARY FIGURES

C.R.D. 5-28-20.

ever, a natural development due to the increased demand for barytes in the manufacture of lithopone and to the greater use of ground barytes and blanc fixe, particularly in the rubber industry. This increase places the United States second as a producer of crude barytes with an output approaching that of Germany prior to the war.

The domestic output of crude barytes increased about fourfold from 1914 to 1916, or from 52,747 short tons to 221,952 short tons. The 1918 production shows a 25 per cent decrease from the output in 1917. Preliminary figures for 1919 indicate an increase in production to about 190,000 tons. Table 2 shows the domestic sales, imports, and apparent consumption of crude barytes. The same data are shown graphically in Figure 2.

TABLE 2.—*Apparent consumption of crude barytes in the United States, 1910–1919.*

[From Mineral Resources, U. S. Geological Survey.]

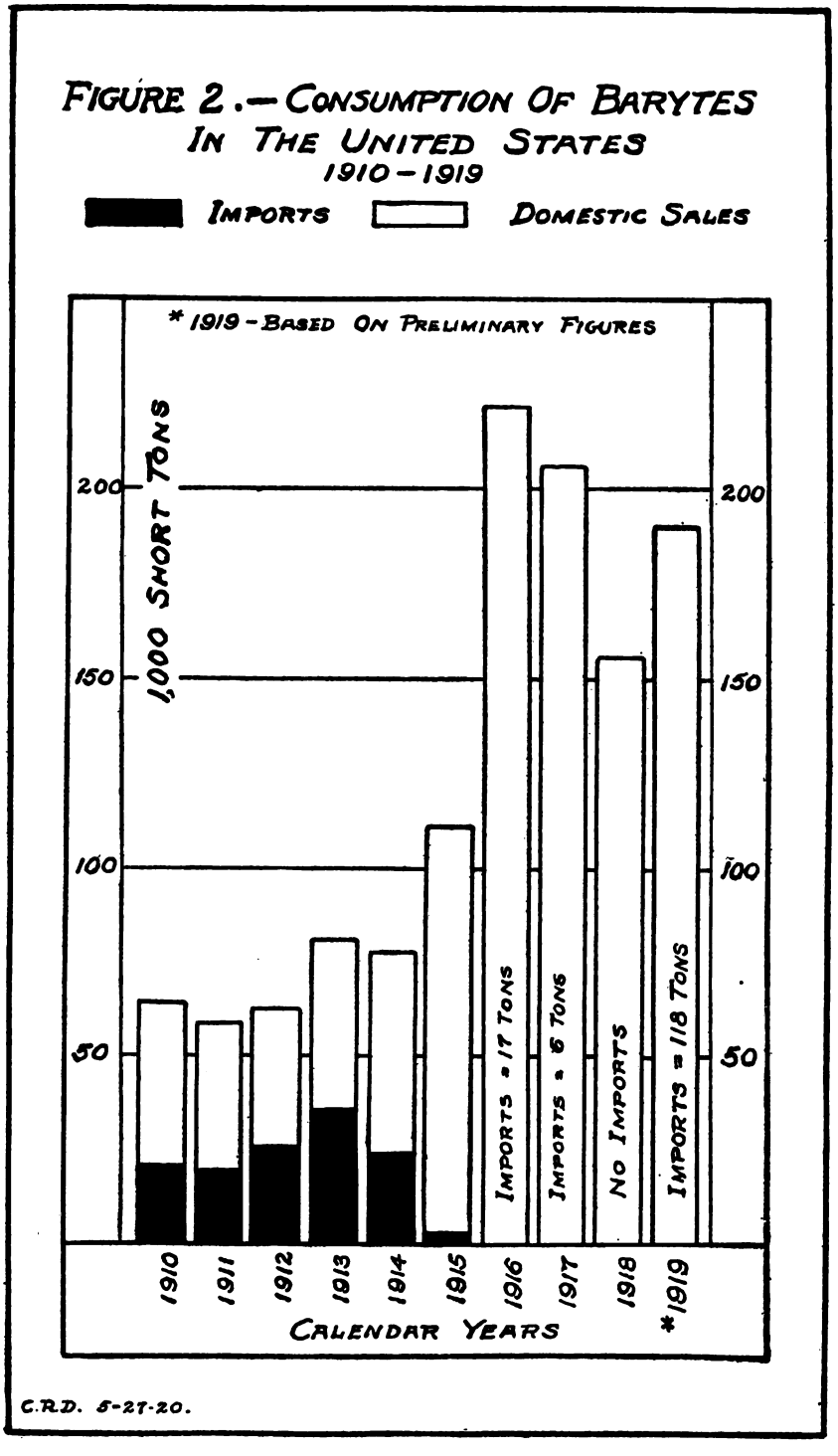
Calendar year.	Sales of domestic barytes.	Imports for consumption.	Apparent consumption.	Calendar year.	Sales of domestic barytes.	Imports for consumption.	Apparent consumption.
	Short tons.	*Short tons.*	*Short tons.*		*Short tons.*	*Short tons.*	*Short tons.*
1910	42,975	21,270	64,245	1915	108,547	2,504	111,051
1911	38,445	20,214	58,659	1916	221,952	17	221,969
1912	37,478	26,186	63,664	1917	206,888	6	206,894
1913	45,298	35,840	81,138	1918	155,368	.....	155,368
1914	52,747	24,423	77,170	1919	[1] 190,000	118	190,118

[1] Preliminary figure furnished by courtesy of the U. S. Geological Survey, subject to revision.

Geographical distribution.—Until 1915 about 65 per cent of the domestic output of crude barytes was mined in the State of Missouri. This location of the domestic barytes mining industry was due, as has been pointed out, to domination of the eastern markets by imported crude barytes. Conditions brought about by war caused a marked change in the domestic industry. In 1915 the output of crude barytes in Georgia about equaled that of Missouri, and in 1916 Georgia became the chief producing State, with a production nearly twice that of Missouri, although the production of Missouri had almost doubled. Since 1915 Georgia has contributed about 50 per cent of the total domestic production. The shifting of the greatest production of crude barytes from Missouri to Georgia was due to the cessation of imports of barytes and barium chemicals from Germany, lower freight rates to eastern factories making lithopone and barium chemicals, and the geological character of the deposits which permitted mining by means of the steam shovel.

War developments, although greatly increasing the output and consumption of crude barytes, still leave the industry divided between two distinct localities—(1) the middle western district, with Missouri as the chief producer, and (2) the southern district, repre-

FIGURE 2.—CONSUMPTION OF BARYTES IN THE UNITED STATES 1910–1919



sented chiefly by Georgia and to a lesser extent by Tennessee and Kentucky. The western district supplies lithopone manufacturers in the St. Louis and Chicago districts as well as local manufacturers of ground barytes who ship about one-half of their output into eastern markets. Very little crude barytes from the middle western district is shipped to eastern markets, because of disadvantages as to freight charges. The southern district supplies crude barytes to eastern manufacturers of lithopone who formerly obtained this raw material chiefly from Germany, and also supplies the requirements of the new barium chemical industry which has been developed since the beginning of the war to supply chemicals formerly obtained by importation.

Table 3 shows the production of crude barytes by States since 1910.

TABLE 3.—*Production of crude barytes, by States, 1910–1918.*

[From Mineral Resources, U. S. Geological Survey.

State.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons		*Short tons.*		*Short tons.*	
Missouri	22,978	$75,598	21,500	$81,380	24,530	$117,035
Tennessee, Kentucky	6,503	13,348	8,819	20,053	3,718	8,682
All other	13,494	32,800	8,126	21,359	9,230	27,596
Total	42,975	121,746	38,445	122,792	37,478	153,313

State.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama					(1)	(1)
Colorado					(1)	(1)
Georgia					31,027	$102,825
Kentucky					7,753	28,427
Missouri	31,131	$117,638	33,317	$112,231	39,113	158,597
North Carolina					(1)	(1)
Tennessee	2,098	3,568	10,113	16,273	25,074	71,290
All other	12,069	35,069	9,317	27,143	5,580	19,793
Total	45,298	156,275	52,747	155,647	108,547	381,032

State.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	7,631	$27,198	1,976	$8,868	1,794	$9,976
Colorado	481	3,005				
Georgia	104,784	401,295	111,300	601,895	69,318	418,178
Kentucky	11,068	54,995	6,720	36,084	(1)	(1)
Missouri	58,223	365,111	59,046	391,363	49,094	393,738
North Carolina	878	3,246	1,019	5,080	(1)	(1)
Tennessee	32,416	123,986	16,972	79,058	22,542	141,844
All other	6,471	32,396	9,855	48,836	12,620	81,169
Total	221,952	1,011,232	206,888	1,171,184	155,368	1,044,905

[1] Included in "All other."

Mining of barytes.—The method of mining crude barytes in the two domestic producing districts varies greatly, although in both the mining is a surface operation. In the Missouri district the mining is all done by pick and shovel, while in the southern district it is largely done by means of steam shovels, which permit of larger-scale operations.

In Missouri the crude barytes or "tiff," which is the local name, is mined chiefly by individuals on a small scale, because of the character of the deposits, which are pockets near the surface and which are scattered over a large area. It is doubtful whether the character of the deposits in Missouri will justify modern methods of mining, such as the use of steam shovel followed by log washing. The general method is to sink a shallow pit about 4 feet in diameter, raise the ore by windlass, and then spread it out to dry in order to loosen adhering clay. The dried ore is then placed in a "rattler," which is a wooden box with holes in the bottom. This removes the clay and small pieces of ore. If the crude barytes has quartz or iron minerals adhering to it, these are removed by hand by means of a small hatchet-like tool. After the ore is cleaned it is placed in stock piles until it can be hauled to the railroad for shipment.

The southern barytes deposits have been developed on a more extensive scale than those of the Missouri district. In many cases the large consumers of crude barytes in the East have developed deposits to supply their own requirements. In all of these large-scale developments the barytes is mined by means of the steam shovel. The barytes deposits in the southern districts, as a rule, are more evenly distributed than in the Missouri district, which permits economical mining by means of steam shovels. Developments on a smaller scale in the southern field involve dry mining with picks and shovels in open cuts. When the steam shovel is used the ore-bearing material is loaded into dump cars and hauled a short distance to the washing plant. Here it is "log washed" to remove clay and earthy impurities. It is then passed over a revolving screen. The small pieces which pass through the screen are "jigged" to remove chert and other foreign minerals, while the large material goes on to a "picking belt," where the foreign rock material is picked out by workmen who stand beside the traveling belt. The washed and cleaned ore is conveyed to storage bins for shipment as crude barytes or is subjected to grinding. The proportion of barytes in ore-bearing material in the southern district usually runs from 20 to 35 per cent.

The difference in the methods used in mining barytes in the Missouri district and the southern district is reflected in the capital investment. In Missouri very little capital outlay is necessary. The equipment required by a miner is simply a pick and shovel and a

windlass. The larger firms, however, have an additional capital investment in houses for the miners, which are furnished free of charge. In the southern district a considerable initial capital investment in steam shovels and washing equipment is necessary before the deposits can be worked economically.

Manufacture of ground barytes.—The preparation of ground barytes varies in the different plants and according to the condition of the crude ore. The general practice, however, is to crush the ore to about 1 inch and by log washing to remove clay and earthy material if the crude ore has not already been treated in this manner. The cleaned material is then ground fine, usually in tube mills. The ground barytes suspended in water is either run over classifying screens or water floated to separate any coarse particles. The finely ground barytes is then usually bleached by washing with sulphuric acid, which removes stains due to oxides of iron. The bleached product is then washed several times with water, after which it is dried, pulverized, and packed either in barrels or bags. Very little labor is used in the process of grinding after the ore is shoveled into the first crusher and until it reaches the packing room. The barytes is conveyed mechanically or pumped suspended in water.

Methods of marketing crude barytes.—The method of marketing crude barytes in the United States varies greatly between the southern and western fields. In Missouri some of the crude barytes (tiff) passes through two and sometimes three hands before it reaches the consumer. The miner sells to a local dealer, usually a storekeeper in return for goods. This buyer sells to a larger buyer having access to the railroad, who in turn sells to the consumer. It is seldom that the consumer deals directly with the miners. In recent years, however, there has been a tendency on the part of the large consumers of barytes in Missouri to buy up the Missouri ore-producing lands. At the present time two St. Louis firms have large holdings in the Missouri fields. These firms have local agents who deal directly with the miners on a tonnage basis. The centralization of the industry thus permits of more direct contact between the consumer and the producer.

In the southern fields the methods of marketing are just the reverse of those in the Missouri fields. Many of the deposits are worked by the manufacturers of barium chemicals and lithopone, although some of them have crude barytes to sell. Many of the miners sell direct to the consumers of crude barytes. This difference is due to the sudden shutting off of imports by the war which forced the eastern manufacturers of barium products to seek a domestic supply and resulted in the development of deposits by the manufacturers themselves.

In the Missouri district crude barytes is sold on the basis of the short ton (2,000 pounds), while in the southern district the long ton (2,240 pounds) is used in all transactions in crude barytes.

Freight rates on crude barytes.[1]—The average freight rate on crude barytes from the Cartersville, Ga., district to eastern lithopone manufacturers is $4.45 per short ton. This average is made up of rates ranging from a low rate of $3.75 to Baltimore, Md., and a high rate of $4.73 to Newark, N. J., Grasselli, N. J., Newport, Del., and Palmerton, Pa.

The average freight rate from the Sweetwater, Tenn., district to eastern lithopone manufacturers is $4.47 per short ton, or practically the same as the average freight rate from the Cartersville district. This average is made up of rates varying from a minimum of $3.75 to Baltimore and a maximum of $4.82 to Newark, Grasselli, and Palmerton. Although the average freight rates from Sweetwater and Cartersville to eastern lithopone manufacturers are practically the same, there is little uniformity in rates to given points. In some cases the rate from Sweetwater is higher than the rate from Cartersville and sometimes lower.

The average freight rate from St. Louis, which may be taken as the shipping point for the Missouri district, to eastern manufacturers of lithopone, is $5.69 per short ton. This, compared with the rates from Cartersville and Sweetwater, gives the southern district an advantage in transportation charges to the eastern lithopone district of $1.24 per short ton. The difference in rates has prevented active competition between southern and western crude barytes in the eastern markets. Missouri ore, in order to compete in these markets, would have to absorb the freight differential of $1.24 in lower prices for crude barytes f. o. b. St. Louis.

Table 4 shows the freight rates on crude barytes from the principal producing points to the principal consuming points.

TABLE 4.—*Freight rates on crude barytes per short ton in carload lots.*

[Compiled from files of Interstate Commerce Commission as of May 26, 1920. Rates are current all rail and commodity rates, unless noted.]

To—	From Cartersville, Ga., minimum carload of 60,000 pounds.	From Sweetwater, Tenn., minimum carload of 60,000 pounds.	From St. Louis, Mo., minimum carload of 40,000 pounds.
Camden, N. J	$4.29	.....	$5.60
Newark, N. J	4.73	$4.82	6.00
Grasselli, N. J	4.73	4.82	6.00
Newport, Del	4.73	4.29	5.60
Baltimore, Md	3.75	[2] 3.75	5.40
Palmerton, Pa	4.73	4.82	5.60
Chicago, Ill	[3] 5.54	[4] 4.46	2.10
Philadelphia, Pa	4.29	4.29	5.60

[1] Rates used in this discussion obtaining on May 26, 1920.
[2] From Reagan, Tenn.
[3] Ohio River combination.
[4] Minimum carload weight 44,800 pounds.

Extent of barytes deposits in the United States.—One of the questions of principal importance in considering a duty on barytes is the extent and availability of deposits in the United States. Under the stimulus of war conditions the production of barytes in the United States increased fourfold from 1914 to 1916, and supplied the entire domestic consumption. But there is very little definite information as to the extent of the deposits, and owing to the general nature of the deposits it would be practically impossible to arrive at any accurate estimate of the total domestic barytes resources.

In the absence of official governmental information on the barytes resources of the United States, the Tariff Commission sent out questionnaires to both producers and consumers of barytes requesting information on the extent of domestic deposits. There developed a distinct cleavage of opinion between the two interested groups. The question submitted on the subject was as follows:

For what length of time do you consider that the barytes resources of the United States are capable of supplying the total domestic requirements? Give your reasons.

Manufacturers of lithopone, the largest consumers of barytes, estimated the life of deposits which are being worked at the present time from a minimum of two years to a maximum of seven years. Lithopone manufacturers were supplied prior to the war with German barytes at a cost less than that of domestic barytes. The following statements are taken from consumers' replies to the above question:

"A careful review of the different mining sections in the East leads us to believe that the new developed barytes resources are capable of supplying the domestic requirements for not more than two years."

"From five to seven years. This statement is made after a rather exhaustive study of the various barytes producing districts and spending of considerable money in exploration work, and it is believed that practically all of the commercial deposits have been uncovered."

"At present rate of consumption the known higher grade deposits of to-day will be exhausted in from three to five years. Low-grade ores (90 per cent $BaSO_4$) if they can be made suitable, which is questionable, could supply the markets for a longer period (5 to 10 years)."

On the other hand barytes producers state that domestic deposits can supply the demand for an indefinite period. The following replies are quoted from producers of barytes:

"In the writer's opinion the answer to this question as it stands would be 'indefinitely,' provided the proper stimulus was given. Barytes is one of the most widely distributed mineral substances that we know of. There has, however, up to the last few years been no incentive for the development of American resources, at least in what might be called the eastern seaboard district."

"The fact that several properties have been worked for 15 years past, and are now only developed to a good working basis and are known to be good for 15 to 20 years to come assures us that we are safe as to our supply."

"Unlimited supply in Missouri fields * * *. Portions that have been producing for the past 40 years are still yielding good tonnage, and geologists estimate that the surface ore has only been touched and that heavier deposits lie deeper."

The possibility of increasing the production of barytes is more promising in Georgia and Tennessee than in the Missouri district. The first two districts seem to contain large quantities of ore and could probably be developed to a point where they would supply an increased demand of eastern manufacturers.

Owing to geological and geographical disadvantages, the known domestic deposits in the southern district will probably not be able to compete on even terms in the Atlantic coast market with barytes imported from Germany. The German deposits are of vein formation and require only drilling and blasting to make the ore available for shipment. The known domestic deposits, on the other hand, are of such a character that the ore-bearing material, after mining, requires washing and mechanical separation from foreign rock material—a process which involves additional equipment—before the ore is ready to be marketed as crude barytes. Prior to the war the freight rate from German mines to Atlantic ports was about $3 per ton as compared with the freight rate from Georgia and Tennessee to the eastern markets of about $4.45 a ton. In view of the difference in mining methods and the difference in freight rates, it would appear that competition would be difficult under normal conditions.

In considering a duty on barytes the extent to which the cost of crude barytes enters into the cost of manufactured products should also be taken into account. (See pp. 72 and 87 for further discussion of this phase of the subject.) From the cost figures the effect which a decrease or increase in the cost of barytes would have on the total cost of a particular product can be determined.

PRODUCTION OF BARYTES IN FOREIGN COUNTRIES.

Germany.—Germany has large deposits of crude barytes of an exceedingly good grade and prior to the war was the largest producer of barytes and of barium chemicals. In 1913 she exported 174,235 short tons or nearly four times as much as was produced the same year in this country and three times as much as was produced in the United Kingdom. Her production of crude barytes during 1908 was about 210,000 metric tons (231,000 short tons) valued at around 2,000,000 marks (about $500,000).[1] The exports of Germany as shown by Table 5 increased about 75,000 short tons from 1909 to 1913. This indicates a growth of her output, so it is reasonable to assume that Germany's production of crude barytes just prior to the war was at least 300,000 short tons. The production in the United States during the war increased to a maximum of 221,952 short tons in 1916,

[1] Bartling, Dr. Richard: "Die Schwerspatlagerstaten Deutschlands," 1911.

which gives the United States an output second only to that of Germany.

Table 5, which shows the German exports and imports of barytes and celestite (natural strontium sulphate, which is relatively unimportant in quantity), is indicative of the growth of the industry in that country.

TABLE 5.—*Germany's exports and imports of barytes and celestite.*[1]

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

Year.	Exports.		Imports.	
	Short tons.	Value.	Short tons.	Value.
1909	99,819	$705,310	16,049	$104,093
1910	125,962	787,489	6,373	41,209
1911	141,512	788,680	8,737	56,692
1912	157,581	992,818	20,575	133,392
1913	174,235	1,058,084	21,457	139,109

[1] Celestite is naturally occurring strontium sulphate. It is relatively unimportant in quantity compared with barytes so that figures may be taken for all practical purposes as representing barytes.

United Kingdom.[2]—The United Kingdom in 1919 ranked third in the production of crude barytes. In 1913 her production exceeded that of the United States by about 10,000 tons. Production, however, has increased during the war more rapidly in the United States than in the United Kingdom, so that the output in this country in 1917 was almost three times that of Great Britain. The United Kingdom, in addition to having large and valuable deposits of barytes, possesses deposits of witherite (barium carbonate) which can be mined economically. The total annual output of witherite in the United Kingdom since 1880 has varied between 6,000 and 12,000 short tons, the maximum output occurring in 1910. Table 6 gives the production, value at mine, and unit value of crude barytes and witherite produced in the United Kingdom.

TABLE 6.—*Production of barytes and witherite in the United Kingdom.*[3]

Year.	Quantity (short tons).	Value at mine.	Unit value per short ton.	Year.	Quantity (short tons).	Value at mine.	Unit value per short ton.
1900	32,991	$142,316.00	$4.31	1910	$50,027	$213,683.00	4.27
1901	30,927	135,337.00	4.38	1911	49,412	196,538.00	3.98
1902	26,441	109,078.00	4.13	1912	50,822	191,886.00	3.78
1903	27,184	108,620.00	4.00	1913	56,050	205,055.00	3.66
1904	29,486	120,071.00	4.07	1914	54,802	211,722.00	3.86
1905	32,551	144,136.00	4.43	1915	69,974	388,488.00	5.55
1906	40,034	171,700.00	4.29	1916	85,158	620,435.00	7.29
1907	47,011	187,068.00	3.98	1917	73,424	687,797.00	9.37
1908	43,621	171,403.00	3.93	1918	74,323	(4)	(4)
1909	46,778	197,230.00	4.22				

[2] Abstracted from the following official publications of the United Kingdom: Report of the Controller of the Department for Development of Mineral Resources in the United Kingdom, 1918, Cd. 9184; and Carruthers, R. G. et al., Special Reports on the Mineral Resources of Great Britain, Vol. II.—Barytes and Witherite, Memoirs of the Geological Survey of Great Britain.

[3] From Mines and Quarries, Part III, Geenral Report, with Statistics by Chief Inspector of Mines, Home Office of Great Britain.

[4] Value not available.

The normal annual requirements for crude barium mineral in the United Kingdom amounted to about 100,000 tons. Of this quantity, in normal times, about 60 per cent was imported, chiefly from Germany. Prior to the war little attention was given in the United Kingdom to the proper treatment of the raw barytes. The result was the domination of the British market by Germany, who produced a grade of superior quality as to whiteness and fineness of grinding. Prior to the war the best grade of German ground barytes sold at about 50 shillings ($12.16), and the second grade at 30 shillings ($7.30) per ton delivered in London. A product equal in quality to that formerly imported into the United Kingdom is now being supplied by English manufacturers. A conservative estimate places the quantity of high-grade barytes ore "in sight" in 1918 in the United Kingdom at 500,000 tons, which is equivalent to a five-year supply. There are, however, many large and undeveloped deposits in both England and Ireland, so that requirements of the United Kingdom can be supplied for many years.

About 70 per cent of the barytes consumed in the United Kingdom is used in the manufacture of lithopone and paints. The remainder is used in paper, rubber, and linoleum manufacture. Witherite is used chiefly by chemical manufacturers in the production of barium chemicals.

Table 7 gives the production, imports, exports, and apparent consumption of barytes in the United Kingdom:

TABLE 7.—*Apparent consumption of barytes in the United Kingdom.*

Calendar year.	Production.	Imports.[1]	Exports.[1]	Apparent consumption.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
1910	50,027	50,876	12,874	88,029
1911	49,412	54,054	9,432	94,034
1912	50,822	64,412	9,933	105,301
1913	56,050	61,188	6,425	110,813
1914	54,802	35,379	3,337	86,844
1915	69,974	7,937	2,748	75,163
1916	85,158	10,343	4,733	90,768
1917	73,424	1,566	4,207	70,783
1918	74,323	1,658	1,757	74,224
1919	.....	22,972	1,360	.....
1920 (5 months)	.....	13,271	317	.....

[1] From the Annual Statement of the Trade and Commerce of the United Kingdom.

Other foreign countries.[2]—Other foreign countries which produce barytes in appreciable quantities are Belgium, Spain, France, and Italy. The output of Belgium has varied considerably, but may be taken as between 20,000 and 30,000 tons. The production of Italy increased during the war from 13,000 tons in 1914 to about 19,000 tons in 1917. The production of France prior to the war was about

[2] Figures of production from Mineral Industry, New York, 1918.

12,000 tons; statistics for later years are not available. The output of barytes in Spain increased from 4,000 tons in 1915 to about 10,000 tons in 1917.

IMPORTS INTO THE UNITED STATES.

The imports of crude barytes were increasing prior to the war, and in 1914 amounted to 36,456 short tons, valued at $63,260. The imports of ground or manufactured barytes were considerably less and in 1914 had reached 6,026 short tons, valued at $42,625. Imports, which were almost wholly from Germany, were shut off with the outbreak of the war, and there have been practically no imports of barytes since 1915.

Tables 8 and 9 show the imports for consumption of crude and ground barytes since 1910.

TABLE 8.—*Imports of crude barytes for consumption in the United States, 1910–1919.*

[Baryta, sulphate of, or barytes, including barytes earth, unmanufactured.]

Fiscal year.	Rate of duty.	Quantity (short tons).	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1910 [1]	75 cents per ton	2,500	$10,824	$1,674	$4.33	15.47
1910 [2]	$1.50 per ton	9,395	21,286	12,582	2.27	59.11
1911	do	20,602	45,06.	27,592	2.19	61.23
1912	do	23,507	40,941	31,482	1.74	76.90
1913	do	31,761	63,345	42,537	1.99	67.15
1914 [3]	do	6,680	12,313	8,946	1.84	72.65
1914 [4]	15 per cent. ad valorem	29,776	50,947	7,642	1.71	15.00
1915	do	10,770	21,087	3,163	1.96	15.00
1916	do	17	245	37	14.41	15.00
1917	do					
1918	do	6	63	9	10.50	15.00
1919	do	39	245	37	6.28	15.00

[1] From July 1 to Aug. 5, 1909.
[2] From Aug. 6, 1909, to June 30, 1910.
[3] From July 1 to Oct. 3, 1913.
[4] From Oct. 4, 1913, to June 30, 1914.

TABLE 9.—*Imports of ground barytes for consumption in the United States, 1910–1919*

[Baryta, sulphate of, or barytes, including barytes earth, manufactured.]

Fiscal year.	Rate of duty.	Quantity (short tons).	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1910	$5.25 per ton	3,023	$27,191	$14,169	$8.99	52.11
1911	do	3,655	26,462	17,131	7.24	64.74
1912	do	3,012	21,642	14,117	7.19	65.23
1913	do	5,145	36,819	24,119	7.16	65.51
1914 [1]	do	1,107	7,520	5,184	6.79	68.94
1914 [2]	20 per cent ad valorem	4,919	35,105	7,021	7.14	20.00
1915	do	1,966	14,997	2,999	7.63	20.00
1916	do		2			20.00
1917	do	235	3,813	763	16.23	20.00
1918	do					20.00
1919	do					20.00

[1] From July 1 to Oct. 3, 1913.
[2] From Oct. 4, 1913, to June 30, 1914.

PRICES.

United States.—The average dutiable value of crude barytes imported from 1912 to 1915, inclusive, was $1.85 per short ton, as shown by import statistics. Information from consular invoices shows that the prewar price of crude barytes was about $1.75 per short ton f. o. b. German mines. Freight charges from the mine to Atlantic ports made the price of crude barytes about $4.70 per short ton ex ship at New York or Philadelphia. To this price must be added the duty under the act of 1913 and barge or switching charge to eastern consumers, so that the price delivered at plants was about $5.20 per short ton. This price varied somewhat according to individual conditions, but the figures given may be taken as an average. Table 10 shows the detail of the price of imported crude barytes for 1914:

TABLE 10.—*Average price per short ton of crude barytes imported from Germany,*[1] *1914.*

Price f. o. b. mine	$1.75
Railroad and river freight to Rotterdam	1.20
Ocean freight	1.75
Price ex ship New York or Philadelphia (duty not paid)	4.70
Price delivered at plants on Atlantic coast[2]	5.20

The price of domestic crude barytes f. o. b. St. Louis has about doubled during the war. The price from May, 1913, until November, 1915, varied very little from $4.90 per short ton. The price then increased to $9.80 per ton in October, 1918, and this price was in force until May, 1919, when it decreased to $8.80 per ton. In November, 1919, the price increased sharply to $10.80 per ton. Table 11 shows the market price of crude barytes per short ton f. o. b. Missouri shipping points.

TABLE 11.—*Market price of crude barytes f. o. b. Missouri shipping points.*

[Dollars per short ton.]

Date.	Washington County, Mo., district.	St. Louis, western Missouri district.
1912, January to October	$4.25	$4.90
1912, October to December, inclusive	5.50	6.15
1913, January to May	7.00	7.65
1913, May to December, inclusive	4.25	4.90
1914, entire year	4.25	4.90
1915, January to November	4.25	4.90
1915, November and December	4.50	5.15
1916, January	4.50	5.15
1916, February and March	5.00	5.65
1916, April to December, inclusive	7.00	7.65
1917, entire year	7.00	7.65
1918, January to August	7.00	7.80
1918, August and September	8.00	8.80
1918, October to December, inclusive	9.00	9.80
1919, January to May	9.00	9.80
1919, May to November	8.00	8.80
1919, November and December	10.00	10.80
1920, January to April	10.00	10.80

[1] From consular invoices of individual shipments.

[2] Includes duty under the act of 1913 and barge or switching charge to plant.

Contract prices on Missouri ground barytes f. o. b. St. Louis have not increased in the same ratio as crude barytes. Table 12 shows contract prices of ground barytes f. o. b. St. Louis in carload shipments.

TABLE 12.—*Contract price of Missouri ground barytes f. o. b. St. Louis in carload shipments.*

Year.	Per short ton.	Year.	Per short ton
1912	$13.00	1917	$19.00
1913	15.50	1918	19.00
1914	13.00	1919	21.50
1915	13.00	1920	21.50
1916	13.00		

The price of crude barytes f. o. b. Cartersville, Ga., increased from $4.25–$6.00 per short ton in 1916 to $8.95 per short ton in the first half of 1920. The price of ground barytes f. o. b. Cartersville has been more constant than that of crude barytes. The price of ground barytes was $17.85 per short ton from 1916 to 1918, inclusive, and then increased to $18.75 in 1919 and the first part of 1920. Table 13 shows the price of crude and ground barytes f. o. b. Cartersville, Ga., since 1916:

TABLE 13.—*Prices of crude and ground barytes per short ton f. o. b. Cartersville, Ga.*

Year.	Crude.	Ground.
1916	$4.25–$6.00	$17.85
1917	4.90– 6.70	17.85
1918	6.45– 8.00	17.85
1919	7.35– 8.95	18.75
1920	8.95	18.75

United Kingdom.—Price quotations on crude barytes in the United Kingdom are not available. Table 6, which gives the production of crude barytes in the United Kingdom shows an average reported value of $3.86 per short ton in 1914, which increased to $9.37 in 1917, the latest year for which complete statistics are available. The increase in the price of ground barytes in the United Kingdom during the war was about in the same proportion as in this country. The increase, however, began in 1912 and shows a gradual trend upward from that time, while the increase in price in the United States did not begin until 1916. The price in the United Kingdom has usually been lower than the price in this country. Table 14 shows the price of ground barytes by quarters in the United Kingdom as quoted by the Chemical Trade Journal and Chemical Engineer of London.

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TABLE 14.—*Price of ground barytes in the United Kingdom, 1910–1919; per short ton.*[1]

1910—January	$9.77–$14.12	1915—January	$16.29–$19.55
April	9.77– 14.12	April	17.38– 20.63
July	9.77– 14.12	July	18.46– 21.72
October	9.77– 14.12	October	19.55– 26.06
1911—January	9.77– 14.12	1916—January	19.55– 26.06
April	9.77– 14.12	April	19.55– 26.06
July	9.77– 14.12	July	19.55– 32.58
October	9.77– 14.12	October	19.55– 32.58
1912—January	9.77– 14.12	1917—January	19.55– 32.58
April	9.77– 14.12	April	21.72– 36.92
July	10.86– 14.12	July	21.72– 36.92
October	10.86– 14.12	October	21.72– 36.92
1913—January	11.95– 16.29	1918—January	21.72– 36.92
April	13.03– 16.29	April	30.41– 60.83
July	13.03– 16.29	July	30.41– 60.83
October	13.03– 16.29	October	39.10– 65.18
1914—January	13.03– 16.29	1919—January	39.10– 65.17
April	13.03– 16.29	April	39.10– 65.17
July	13.03– 16.29	July	30.42– 60.83
October	16.29– 19.55	October	30.42– 60.83

[1] Taken from Chemical Trade Journal and Chemical Engineer, London. Listed as barium sulphate, native levigated, f. o. r. at works or usual ports of shipment.

Germany.—Barytes is not regularly quoted in German chemical trade journals. The following prices are offerings of crude and ground barytes, which were received by American firms from German firms.[1] The prices quoted in these letters are tabulated and converted in Tables 15 and 16 at the par value of the mark and at the exchange value of the mark on the date the letters were written.

TABLE 15.—*Prices of crude barytes, free Hamburg or Bremen, Oct. 21, 1919.*

Grade.	Price per short ton.		
	Marks.	Mark = $0.2382.	Mark = $0.036.
No. 1 = 98 to 99 per cent	65	$15.48	$2.34
No. 2 = 95 to 96 per cent	60	14.29	2.16

TABLE 16.—*Price of crude barytes, free Bremen, Hamburg, or Rotterdam, Sept. 30, 1919.*

Brand.	Class.	Price.		
		Marks per metric ton.	Dollars per short ton.	
			Mark = $0.2382.	Mark = $0.04.
S W O O O	1	329.5	$71.20	$11.96
Lowe	3	318.5	68.83	11.56
Adler	6	304.5	65.80	11.05
G O O O	8b	292.5	63.21	10.61

[1] Original letters in files of the Tariff Commission.

COMPETITIVE CONDITIONS.

The situation prior to the war.—The Atlantic coast market for crude barytes was supplied exclusively by imports, chiefly from Germany, amounting to between 35 and 45 per cent of the total domestic consumption of crude barytes. The interior points at which imported barytes could compete with the domestic ore produced in Missouri depended wholly on the cost of transportation or freight rates to the market in question. The outlet for domestic crude barytes prior to the war was thereby restricted to supplying the middle western manufacturers of ground barytes, while the imported crude barytes was consumed almost wholly by eastern manufacturers of lithopone.

This division of the domestic market did not exist in the case of ground barytes. Under the duties in the act of 1909 for ground or manufactured barytes ($5.25 per ton), domestic ground barytes was able to compete in the Atlantic coast market with imported ground barytes. It is estimated that prior to the war about 50 per cent of the ground barytes manufactured in the Middle West was shipped to and consumed in the Atlantic coast market. The imports of ground or manufactured barytes prior to the war were only about 15 per cent of the imports of crude barytes, which shows that the competition between domestic and foreign barytes was chiefly in the crude ore. Table 17 shows the imports of ground and crude barytes for 1911 to 1913, inclusive.

TABLE 17.—*Comparison of imports of crude and ground barytes, 1911–1913.*

Fiscal year.	Ground barytes.	Crude barytes.
	Short tons.	*Short tons.*
1911	3,655	20,602
1912	3,012	23,507
1913	5,145	31,761

The present situation.—The deposits of barytes in the southern district have an advantage over Missouri deposits of about $1.25 per short ton in freight rates to the Atlantic coast market. War conditions have therefore not changed the competitive situation as far as middle western producers of crude barytes are concerned. With normal conditions restored competition in crude barytes in the Atlantic coast market will be between the foreign product and domestic crude barytes produced in Georgia, Tennessee, and Kentucky; crude barytes produced in Missouri will not be able to compete in this market even under existing conditions.

In the matter of ground barytes, however, the manufacturers in the Middle West continue to ship about 50 per cent of their product

to the Atlantic coast market. Although ground barytes from the southern district has a lower freight rate to Atlantic coast markets than Missouri ground barytes, the Missouri product still supplies a large portion of this market. This may be explained by the fact that eastern lithopone and barium chemical manufacturers developed the southern deposits chiefly to supply their raw-material requirements. Missouri barytes is a softer variety and is better adapted for the manufacture of ground barytes than is the southern ore. It is evident that the producers of crude barytes in the southern district are particularly interested in retaining the Atlantic coast market for crude barytes while the Missouri producers and manufacturers of ground barytes are more interested in being able to hold this market for ground barytes, which they largely supplied prior to the war.

TARIFF HISTORY.

Barytes or barium sulphate, unmanufactured or manufactured, has been dutiable since the passage of the act of 1883, with the exception of the period covered by the act of 1894, when barytes unmanufactured, including barytes earth, was free of duty. Witherite (natural barium carbonate) has uniformly been exempt from duty since 1883. The duties levied on barytes, unmanufactured and manufactured, and the provisions for witherite beginning with the act of 1883 are as follows:

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	40	Baryta, sulphate of, or barytes, unmanufactured	10 per cent ad valorem.
1883	41	Baryta, sulphate of, or barytes, manufactured	¼ cent per pound.
1883	603	Baryta, carbonate or witherite	Free.
1890	49	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	$1.12 per ton.
		Manufactured	$6.72 per ton.
1890	500	Baryta, carbonate of, or witherite	Free.
1894	37	Baryta, sulphate of, or barytes, manufactured	$3 per ton.
1894	395	Baryta, carbonate of, or witherite, and baryta, sulphate of, or barytes, unmanufactured, including barytes earth.	Free.
1897	44	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	75 cents per ton.
		Manufactured	$5.25 per ton.
1897	489	Baryta, carbonate of, or witherite	Free.
1909	42	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	$1.50 per ton.
		Manufactured	$5.25 per ton.
1909	711	Witherite	Free.
1913	51	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	15 per cent ad valorem.
		Manufactured	20 per cent ad valorem.
1913	646	Witherite	Free.

CONSTRUCTION OF THE LAW.

In a case under the act of 1894 in which the importers furnished no evidence to support their protest, ground carbonate of baryta was held dutiable as an unenumerated manufactured article and not

exempt from duty as native or unmanufactured carbonate of baryta or witherite of commerce. (G. A. 3622, T. D. 17483.) Under the act of 1897 which removed the limitation to carbonate of baryta in its unmanufactured condition, ground carbonate of baryta was held exempt from duty. (G. A. 4243, T. D. 19947.) In a court decision likewise classifying precipitated carbonate of baryta, paragraph 489 of the act of 1897 was declared not limited to the particular kind of carbonate of baryta known as witherite, but included all carbonates of baryta whether or not known by the name of witherite. (Gabriel & Schall *v.* United States, 121 Fed., 208; followed by the Board of General Appraisers in G. A. 5314, T. D. 24331, and G. A. 7141, T. D. 31145.) A like conclusion was reached by the Court of Customs Appeals. (United States *v.* Gabriel & Schall, 1 Ct. Cust. Appls., 90.) The provision for "witherite" in paragraph 711 of the act of 1909 was, however, declared to be limited to the natural crude mineral ore and not inclusive of precipitated carbonate of baryta, which, being a chemical salt, was held dutiable under paragraph 3 of that act. (G. A. 7262, T. D. 31810.)

THE BARIUM CHEMICAL INDUSTRY

THE BARIUM CHEMICAL INDUSTRY.

DESCRIPTION AND USES.

The term "barium chemicals" is used in this report to include various barium salts or compounds which are manufactured by chemical processes from the barium minerals, barytes and witherite.

Blanc fixe or artificial sulphate of barytes, as it is described in the tariff act of October 3, 1913, is barium sulphate which has been precipitated from a solution of a soluble barium salt by means of a sulphate, usually salt cake. The term "blanc fixe," which means permanent white, is generally used in commerce to designate this article. The term "precipitated barium sulphate" describes the product much more accurately than artificial sulphate of barytes. As the term "barytes" alone signifies barium sulphate, the phrase "sulphate of barytes" is redundant. Blanc fixe is the best grade of barium sulphate for pigment purposes, both as to whiteness and fineness of the product. In chemical composition blanc fixe is practically identical with natural ground barytes, but its physical properties are different. The two products should not be confused. Blanc fixe is largely used where a pure white pigment or filler is desired, as in paints, rubber goods, linoleum, oilcloth, and glazed paper. It is also used in lithographic inks, as a base for lake colors, and is used extensively as a pigment by the United States Navy in "battleship gray," which contains about 45 per cent of blanc fixe. Blanc fixe under the name of chemically pure barium sulphate is used as an indicator in X-ray photography. It is placed on the market in pulp and as a dry powder. The pulp is a paste containing about 30 per cent of water and is used chiefly by the paper and lithographic ink manufacturers. The dry powder is used for pigment purposes.

Barium carbonate is a white insoluble barium salt prepared by precipitation from a solution of barium sulphide with soda ash. Its largest use is in the ceramics industry for the manufacture of optical glass, for which purpose a chemically pure product is required. Recently it has assumed importance in the manufacture of flat wall paints, and this use will undoubtedly increase. These

paints when containing about 45 per cent of precipitated barium carbonate produce a velvety finish. Witherite (natural barium carbonate) can not be used for this purpose and should not be confused with precipitated barium carbonate. It is also used as the raw material for making barium peroxide and in the manufacture of some kinds of enameled iron ware.

Barium chloride is a white barium salt which is fairly soluble in water. It crystallizes with two molecules of water and is usually sold in the crystalline or powdered form. It is largely used in the manufacture of blanc fixe and of color lakes as a mordant for fixing acid dyes on the inert base, such as aluminum hydroxide or blanc fixe. Barium chloride is also used in the purification of salt, as a water softener, a chemical reagent in sulphur determinations, to some extent in the ceramics industry, and in the manufacture of certain photographic chemicals. It has certain medicinal uses.

Barium nitrate is a soluble barium salt used principally for making barium peroxide or dioxide. It is also used in pyrotechnics for making green fire and green signal lights and in the manufacture of certain explosive mixtures, thus giving barium nitrate some military significance. It also has certain medicinal uses similar to barium chloride.

Barium monoxide or baryta has its chief use as an intermediate product in the preparation of the binoxide or peroxide of barium. It is also used in the manufacture of certain varieties of optical glass. In European countries, especially Germany, it is used in refining beet sugar.

Barium hydroxide, hydrate of baryta, or caustic baryta, has very little commercial use in the United States. During the period of high prices for caustic potash, barium hydroxide was used to convert sulphate of potash into caustic potash. In Europe it is used with barium monoxide in the refining of beet sugar.

Barium binoxide, barium dioxide, or barium peroxide, is used chiefly for the manufacture of hydrogen peroxide. It is also used for the production of oxygen and as a bleach, especially in the blanket and straw hat industries. Large quantities of hydrogen peroxide were required for war purposes. This demand and the use of barium peroxide in tracer bullets resulted in a large increase in production.

Barium sulphide is the intermediate barium compound from which the majority of the other barium chemicals are made and is one of the necessary materials in the manufacture of lithopone. It is also used with lime as a depilatory in leather manufacture. Crude barium sulphide, which is made by roasting barytes with coal, is known as "black-ash."

Barium chromate or lemon yellow, or yellow ultramarine, is used as a yellow pigment.

Barium chlorate is used in pyrotechnics and in dyeing.

DOMESTIC PRODUCTION.

Production and consumption.—Prior to the war the United States was almost wholly dependent on imports for its supply of barium chemicals. There was practically no domestic production of the barium salts such as barium dioxide, chloride, nitrate, and blanc fixe. The only product manufactured in this country on a large scale prior to the war, which utilized barytes as a raw material, was lithopone, which is discussed on pages 53–60.

The shutting off of imports with the outbreak of the war gave a great stimulus to the establishment of a barium chemical industry in the United States. In addition there were large war demands for certain barium salts (barium peroxide, blanc fixe, and barium nitrate) which greatly increased the domestic production and tended to develop an industry in the United States. Plants for the manufacture of barium salts have been located chiefly in the eastern and southern sections of the United States. The southern plants are located in close proximity to the raw material barytes. There are also plants located in Ohio and Illinois. The following is a list of the principal manufacturers of barium chemicals in the United States:

Alton Chemical Corporation, Alton, Ill.
Chicago Copper & Chemical Co., 111 West Jackson Boulevard, Chicago, Ill.
Consolidated Chemical Products Co., Alton, Ill.
Durex Chemical Corporation, 320 Fifth Avenue, New York City. (Plant at Sweetwater, Tenn.)
E. I. du Pont de Nemours & Co., Wilmington, Del.
J–H–R. Products Co., Willoughby, Ohio.
Oakland Chemical Co., 10 Astor Place, New York City.
Rollin Chemical Corporation, 120 Broadway, New York City. (Plant at Charleston, W. Va.)

The production of barium chemicals has increased steadily from 17,646,000 pounds in 1915 to 46,372,000 pounds in 1918. Preliminary figures furnished by the Geological Survey indicate a total production of barium chemicals during 1919 of about 41,500,000 pounds. The order of the barium salts according to quantity of production during 1918 was blanc fixe, barium carbonate, and barium chloride. Table 18 shows the domestic output of barium chemicals, beginning with 1915.

TABLE 18.—*Production of barium chemicals in the United States, 1915–1918.*

[From Mineral Resources, United States Geological Survey.]

	1915	1916	1917	1918
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Barium binoxide	(1)	3,960,000	(1)	(1)
Barium carbonate	5,492,000	13,668,000	16,476,000	15,322,000
Barium chloride	4,212,000	7,286,000	9,740,000	9,060,000
Barium nitrate	1,942,000	892,000	330,000	(1)
Barium sulphate or blanc fixe	(1)	6,674,000	12,628,000	19,044,000
All others	6,000,000	1,084,000	5,832,000	2,946,000
Total	17,646,000	33,584,000	45,006,000	46,372,000

[1] Included in "All others."

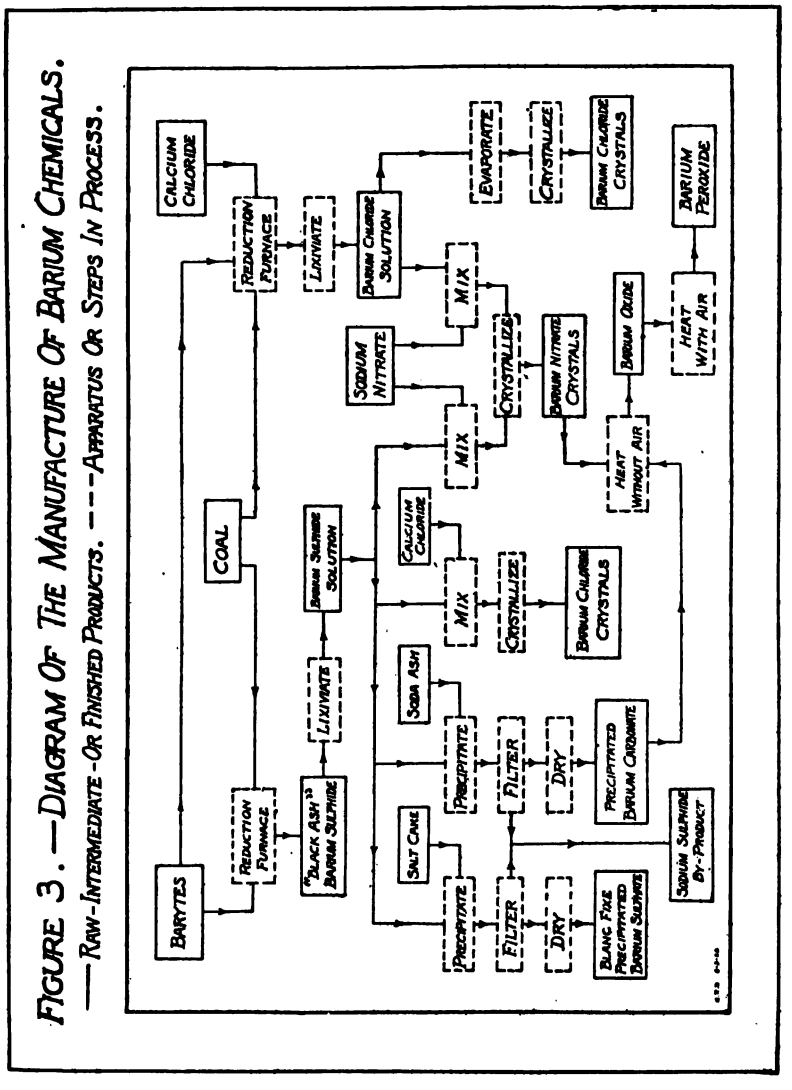
Process of manufacture.—Barytes is the raw material used in the United States for the manufacture of barium chemicals with the exception of a small quantity of witherite which is imported. A deposit of witherite was discovered in California in 1914, but it has not proved to be of commercial importance.

The manufacturers of barium chemicals prefer to use the washed, high-grade barytes of the soft type, but they can and do use the barytes which could not be used in the preparation of the highest grades of ground barytes. The crude barytes is first crushed and mixed with the proper proportions of pulverized coal. The proportion of barytes and coal varies slightly with individual manufacturers; it is generally one part of coal to four parts of barytes by weight. This mixture is roasted for about four hours in a rotating reduction furnace. The barium sulphate is reduced by the coal to barium sulphide during the roasting. The crude barium sulphide (black ash), which contains about 70 per cent of barium sulphide, is then treated with hot water and a solution of barium sulphide is thereby formed. This solution is used as the starting point for the preparation of the barium chemicals and also in the manufacture of lithopone. (See p. 54.)

Barium carbonate is precipitated from a solution of barium sulphide by treatment with sodium carbonate (soda ash). Sodium sulphide is obtained as a by-product. It can also be prepared by passing a current of carbon dioxide gas through the solution of barium sulphide. By this last process, sodium sulphide is not obtained as a by-product.

The method of producing *blanc fixe* or precipitated barium sulphate depends on the physical properties which are desired for the finished product. It was formerly made only by treating a solution of barium chloride with sodium sulphate or sulphuric acid. It is now usually made by precipitation from a solution of barium sulphide by means of salt cake (sodium sulphate). This method produces a much denser product than that produced from barium chloride, and in addition yields sodium sulphide as a valuable

by-product. It is also made as a by-product of the manufacture of hydrogen peroxide when barium peroxide is treated with sulphuric acid. For certain color purposes blanc fixe is precipitated from hot,



concentrated solutions, thus giving a crystalline product which is a valuable base for the manufacture of very brilliant colors.

Barium chloride may be produced by treating witherite (barium carbonate) with hydrochloric acid. It is usually produced in this country directly from crude barytes by roasting with coal and calcium chloride. It may also be prepared by treating a solution of barium sulphide with calcium chloride.

Barium nitrate is produced by adding sodium nitrate (Chile saltpeter) either to a solution of barium chloride or to a solution of barium sulphide. It is also produced by dissolving witherite in a solution of nitric acid. The barium nitrate thus produced can be converted into barium oxide, dioxide, or hydroxide.

Barium chromate is prepared by treating a solution of barium chloride or other soluble barium salts with sodium chromate.

Barium peroxide or dioxide is prepared from either barium nitrate or barium carbonate. The barium nitrate or carbonate is first converted into barium oxide by heating in a closed apparatus. The barium oxide is then converted into barium peroxide by heating at about 700° C. in a current of air free from carbon dioxide and moisture.

Whenever a sodium salt is added to a solution of barium sulphide in the preparation of barium salts there is produced, in addition to the desired barium product, sodium sulphide as a valuable by-product. This is an important product of the barium chemical industry, and has a large consumption by the American dye industry in the preparation of sulphur colors, especially sulphur black, which is used in large quantities.

FOREIGN PRODUCTION.

Although statistics are not available on the production of barium chemicals in foreign countries, it is undoubtedly true that Germany was the largest single producer prior to the war. England, France, and Italy possessed smaller barium chemical industries, and the industries in these countries have also been stimulated by war conditions which prevented exports of barium products from Germany. Table 19, which shows Germany's exports and imports of barium chemicals, indicates the importance of the German industry prior to the war.

TABLE 19.—*Germany's exports and imports of barium chemicals.*

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

	Exports.		Imports.	
	Short tons.	Value.	Short tons.	Value.
Blanc fixe, precipitated barium sulphate:				
1909	5,388	$98,853	15	$238
1910	6,093	111,954	20	476
1911	7,548	197,706	6	238
1912	9,147	222,955	7	238
1913	8,418	219,859	6	.....
Barium chloride:				
1909	5,865	126,722	2,012	43,114
1910	7,114	153,639	2,155	44,305
1911	6,812	154,330	2,217	45,496
1912	8,145	165,787	4,050	78,844
1913	6,227	135,059	2,863	58,835
Barium nitrate:				
1909	676	46,687	.....	.....
1910	1,088	72,889	.....	.....
1911	1,022	67,887	2	238
1912	893	62,885	3	238
1913	1,445	104,570	15	953

IMPORTS INTO THE UNITED STATES.

The imports of all barium chemicals (exclusive of lithopone and blanc fixe) in 1914 were 19,299,702 pounds, valued at $526,824. Of this quantity about 66 per cent came from Germany. About 90 per cent of the importation in 1914 was represented by three barium salts, namely, precipitated barium carbonate, barium chloride, and barium dioxide. Table 20 shows the detail of the imports of barium chemicals in 1914 with countries of origin:

TABLE 20.—*Imports of barium chemicals by countries, fiscal year 1914.*[1]

Article.	Quantity.	Value.	Per cent of quantity, by countries.	
Barium:	*Pounds.*			
Carbonate (precipitated)	5,131,339	$47,648	Germany	80.6
			Belgium	11.9
			England	7.5
Chlorate—				
Commercial crystals	17,680	752	Switzerland	74.4
			England	25.6
Depurative	159	4	Germany	100.0
Chloride	6,118,387	65,443	do	70.4
			Austria-Hungary	29.6
Dioxide (binoxide)	6,085,909	330,142	Germany	45.8
			England	42.0
			Belgium	12.2
Hydroxide—				
Commercial crystals	104,790	1,612	Germany	95.4
			England	4.0
			Belgium	.6
Chemically pure crystals	148	11	Germany	100.0
Pure exsiccated	2,555	401	do	100.0
Hypophosphite	113	117	England	99.1
			Germany	.9
Nitrate—				
Crystals	1,040,772	38,728	do	98.7
			Belgium	1.1
			England	.2
Powder, fused	2,200	411	Germany	100.0
Oxide—				
Hydrated, commercial crystals	3,047	96	do	100.0
Hydrated, caustic, chemically pure exsiccated.	11	2	do	100.0
Anhydrous chemically pure	4	2	do	100.0
Peroxide—				
Anhydrous commercial powder	707,440	35,423	do	50.4
			England	27.1
			Belgium	22.5
Pure hydrated	24	5	Germany	100.0
Sulphide—				
Crude lumps	12,373	930	do	100.0
Purified	9,360	893	do	100.0
Pure	622	148	do	100.0
Sulphite	837	731	do	100.0
Sulfo cyanide	61,932	3,325	do	97.0
			Canada	3.0
Total	19,299,702	526,824		

[1] Pickrell, Dr. E. R.: Chemicals and Allied Products Used in the United States, Department of Commerce, Miscellaneous Series No. 82.

Imports for consumption.—The imports of barium chemicals have practically ceased since 1915 owing to the severance of trade with Germany which was the chief source of supply. The imports of

practically all the barium chemicals prior to the war had increased to a maximum in 1914. The imports of barium chloride during the last six months of the 1919 calendar year (not shown in Table 21) were 1,096,396 pounds, valued at $19,063. This is the first barium chemical to be imported since the war in anything like the quantity of prewar imports. Table 21 shows the imports for consumption of the most important barium chemicals since 1910:

TABLE 21.—*Imports of barium chemicals for consumption in the United States.*

BARIUM CARBONATE, PRECIPITATED.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1912	25 per cent	946,971	$7,376	$1,844	$0.008	25.00
1913	do	2,182,517	20,143	5,035	.009	25.00
1914[1]	do	485,889	4,384	1,096	.009	25.00
1914[2]	15 per cent	4,509,562	42,041	6,306	.009	15.00
1915	do	344,588	7,864	1,179	.023	15.00
1916	do	6	2		.333	15.00
1917	do	804	177	26	.220	15.00
1918	do	106,288	1,437	215	.014	15.00
1919	do					

BARIUM CHLORIDE.

1910	25 per cent	3,705,502	$33,672	$8,418	$0.009	25.00
1911	do	2,742,486	29,771	7,442	.011	25.00
1912	do	2,834,980	27,766	6,941	.010	25.00
1913	do	2,926,159	26,341	6,585	.009	25.00
1914[1]	do	254,106	2,558	639	.010	25.00
1914[2]	¼ cent per pound	5,856,280	62,005	14,640	.011	23.61
1915	do	4,686,029	60,532	11,715	.013	19.35
1916	do	50	10		.200	1.30
1917	do	6,614	608	16	.092	2.72
1918	do					
1919	do	3,290	783	8	.238	1.05

BARIUM DIOXIDE OR BINOXIDE.

1910	25 per cent	3,563,528	$261,674	$65,418	$0.073	25.00
1911	do	4,896,563	347,129	86,782	.071	25.00
1912	do	3,715,823	255,053	63,763	.069	25.00
1913	do	3,507,508	215,500	53,875	.061	25.00
1914[1]	do	882,385	49,611	12,402	.056	25.00
1914[2]	1½ cents per pound	5,203,413	280,528	78,051	.054	27.82
1915	do	4,084,144	317,262	61,262	.077	19.31
1916	do	546,442	48,451	8,196	.088	16.92
(3)						

BLANC-FIXE OR ARTIFICIAL SULPHATE OF BARYTES, AND SATIN WHITE OR ARTIFICIAL SULPHATE OF LIME.

1910	½ cent per pound	5,656,507	$66,923	$28,282	$0.012	42.26
1911	do	6,332,699	73,278	31,663	.012	43.07
1912	do	5,702,262	70,925	28,511	.012	40.20
1913	do	4,808,726	58,499	24,043	.012	41.10
1914[1]	do	1,166,525	16,837	5,832	.014	34.72
1914[2]	20 per cent	3,585,949	43,804	8,760	.012	20.00
1915	do	2,233,369	25,748	5,149	.011	20.00
1916	do	492,723	11,523	2,304	.023	20.00
1917	do	408,163	10,029	2,005	.024	20.00
1918	do	179,200	2,376	475	.013	20.00
1919	do	1,285	90	18	.070	20.00

[1] From July 1 to Oct. 3, 1913.
[2] From Oct. 4, 1913 to June 30, 1914.
[3] No imports from 1917 to 1919, inclusive.

PRICES.

The price of barium chemicals increased more during the war than barytes, the raw material. This was undoubtedly due to the fact that this country did not possess a barium chemical industry and therefore the normal demand could not be met with the sudden cessation of imports from Germany. The price of barium chemicals increased rapidly to a high level in the latter part of 1916, which was three and four times the prewar prices. As the production of domestic manufacturers approached the demand, the prices declined somewhat (with the exception of barium chlorate). The prices existing during 1918 and 1919 were about twice the normal prewar prices. Prices of barium carbonate have not been quoted prior to 1919. During 1919 and the first half of 1920 the price was between $65 and $75 per ton. Table 22 shows the price by quarters of the various barium chemicals, as quoted in the Oil, Paint and Drug Reporter.

TABLE 22.—*Price of barium chemicals in the United States, spot, New York market.*

[From Oil, Paint and Drug Reporter.]

	Pulp blanc fixe, per ton.	Dry blanc fixe, per ton.	Barium salts.			
			Chlorate, per pound.	Nitrate, per pound.	Chloride, per ton.	Dioxide, per pound.
1912.			*Cents.*	*Cents.*		*Cents.*
January	$40.00-$43.00	$57.50-$80.00	15-17	5½- 6¼	$31.50-$32.50	.....
April	40.00- 43.00	57.50- 80.00	15-17	5½- 6¼	28.00- 30.00	.....
July	40.00- 43.00	57.50- 80.00	15-17	5½- 6¼	28.00- 30.00	.....
October	40.00- 43.00	57.50- 80.00	15-17	5.1- 6	27.00- 28.00	.....
1913.						
January	40.00- 43.00	57.50- 80.00	15-17	5¾- 6	32.00- 32.50	.....
April	40.00- 43.00	57.50- 80.00	15-17	5¾- 6	33.00 33.50	.....
July	40.00- 43.00	57.50- 80.00	15-17	5¾- 6	31.50- 32.50	.....
October	40.00- 43.00	57.50- 80.00	13-13½	5¾- 6	32.00- 32.50	.....
1914.						
January	40.00- 43.00	57.50- 80.00	13-13½	5¾- 6	32.50- 33.00	.....
April	40.00- 43.00	57.50- 80.00	13-13½	5¾- 6	32.00- 32.50	.....
July	40.00 43.00	77.50- 80.00	13-13½	5¾- 6	32.00- 32.50	.....
October	40.00- 43.00	77.50- 80.00	16-16½	14 -16	120.00-130.00	.....
1915.						
January	40.00 43.00	77.50- 80.00	16-16½	12 -14	50.00- 60.00	.....
April	40.00- 43.00	77.50- 80.00	16-16½	12 -14	60.00	.....
July	45.00	60.00- 65.00	16-16½	12 -14	70.00- 80.00	22
October	45.00	60.00- 65.00	16-16½	15 -16	95.00-100.00	22
1916.						
January	45.00	80.00	16-16½	15 -16	110.00	22
April	70.00	80.00	50-60	15 -16	..... 140.00	22
July	120.00	120.00-140.00	50-60	15 -16	110.00-120.00	38
October	120.00	90.00	50-60	15 -16	100.00-110.00	38
1917.						
January	80.00- 85.00	110.00	50-60	15 -16	97.50-102.50	38
April	35.00- 40.00	80.00- 85.00	50-60	13 -14	92.50-100.00	38
July	35.00- 40.00	80-00- 85.00	50-60	12 -13	90.00- 95.00	38
October	35.00- 40.00	80.00- 85.00	50-60	12 -13	80.00- 90.00	38

TABLE 22.—*Price of barium chemicals in the United States, spot, New York market*—Continued.

	Pulp blanc fixe, per ton.	Dry blanc fixe, per ton.	Barium salts.			
			Chlorate, per pound.	Nitrate, per pound.	Chloride, per ton.	Dioxide, per pound.
1918.			*Cents.*	*Cents.*		*Cents.*
January	$35.00–40.00	$75.00–80.00	50–60	11–14	$65.00–90.00	20–25
April	35.00–60.00	95.00–105.00	Nominal.	12–14	65.00–85.00	Nominal.
July	35.00–60.00	110.00–120.00	50–60	12–14	[1]65.00–70.00	25–30
October	35.00–60.00	110.00–120.00	50–60	12–14	[1]65.00–70.00	25–30
1919.						
January	35.00–60.00	110.00–120.00	50–60	11½–12	[2]85.00–87.00	25–27
April	35.00–50.00	70.00–90.00	50–60	10–11	82.00–85.00	25–27
July	35.00–50.00	70.00–90.00	50–60	10–11	70.00–80.00	25–27
October	35.00–50.00	70.00–90.00	50–60	10–11	80.00–85.00	25–27
1920.						
January	35.00–50.00	80.00–100.00	59–60	10–11	90.00–95.00	21½–22
April	40.00–50.00	100.00	50–60	17–18	150.00–175.00	23 ..
July	40.00–50.00	120.00	50–60	17–18	175.00–180.00	22½–25

[1] 80 per cent grade. [2] Listed during 1919–20 as barium chloride, white crystals.

TARIFF HISTORY.

Prior to the tariff act of 1913 the only barium chemical mentioned by name was blanc fixe or artificial sulphate of barium, which was first mentioned in the act of 1890 as dutiable at three-fourths cent per pound. The other barium chemicals were dutiable prior to the passage of the act of 1913 as chemical compounds and salts n. s. p. f. The act of 1913 mentions three barium salts by name in addition to mentioning blanc fixe, and alloys of metallic barium. The tariff classification of the finished barium products since the passage of the act of 1883 is as follows:

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883.....	92	* * * and all chemical compounds and salts, * * * not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890.....	51	Blanc-fixe, * * * or artificial sulphate of barytes....	¾ cent per pound.
	76	* * * and all chemical compounds and salts, not specially provided for in this act.	25 per cent ad valorem.
1894.....	39	Blanc-fixe, or artificial sulphate of barytes.....	25 per cent ad valorem.
	60	* * * and all chemical compounds and salts, not specially provided for in this act.	25 per cent ad valorem.
1897.....	46	Blanc-fixe, or artificial sulphate of barytes * * *	½ cent per pound.
	3	* * * and all chemical compounds and salts not specially provided for in this act.	25 per cent ad valorem.
1909.....	3	* * * chemical compounds, mixtures and salts * * * not specially provided for in this section.	25 per cent ad valorem, or 55 cents per lb. if more.
	44	Blanc-fixe, or artificial sulphate of barytes * * *	½ cent per pound.
1913.....	5	* * * and all chemical * * * compounds * * *, mixtures and salts * * * .	15 per cent ad valorem.
	10	Barium,	
		Chloride of.....	¼ cent per pound.
		Dioxide of.....	1½ cents per pound.
		Carbonate of, precipitated.....	15 per cent ad valorem.
	51	* * * blanc-fixe, or artificial sulphate of barytes * * * .	20 per cent ad valorem.
	143	* * * barium, * * * and alloys of which said metals are the component material of chief value.	25 per cent ad valorem.

THE LITHOPONE INDUSTRY

THE LITHOPONE INDUSTRY.

DESCRIPTION AND USES.

Lithopone (incorrectly spelled lithophone) is a white pigment which consists of a mixture of approximately 70 per cent barium sulphate and 30 per cent of zinc calculated as zinc sulphide. The zinc is present in lithopone as 26 to 28 per cent of zinc sulphide and 1 to 3 per cent of zinc oxide, according to conditions of manufacture. The lithopone produced in this country by all manufacturers is a standard product of approximately the composition given above, which is about in proportion to the chemical equivalents of barium sulphate and zinc sulphide. In Europe lithopone is commonly sold in grades containing more or less zinc sulphide than the standard of 30 per cent. For example, the following grades of lithopone are sold on the German market: Gelbsiegel (yellow seal), 11 to 18 per cent zinc sulphide; Blausiegel (blue seal), 22 to 30 per cent zinc sulphide; Grünsiegel (green seal), 32 to 42 per cent zinc sulphide.

Lithopone is known commercially under various brand names in addition to the general name of lithopone. The trade names used by various manufacturers, with the exception of the Sherwin-Williams Co., of Cleveland, Ohio, which firm markets their product simply as lithopone, are as follows:

Beckton White, E. I. du Pont de Nemours & Co., Wilmington, Del.
Ponolith, Krebs Pigment & Chemical Corporation, Newport, Del.
Marbon White, Mineral Refining & Chemical Corporation, St. Louis, Mo.
Zincolith, Chemical Pigments Corporation, Philadelphia, Pa.
Sterling White, Midland Chemical Co., Chicago, Ill.
B–J White, Butterworth-Judson Corporation, New York.
Grasselli White, Grasselli Chemical Co., Cleveland, Ohio.
Green Label and Standard, New Jersey Zinc Co., New York.
Colzo Lithopone, Collinsville Zinc Corporation, St. Louis, Mo.

Lithopone is used extensively as a white pigment in flat and enamel wall paints for interior use. The chief competitors of lithopone as a pigment are white lead, zinc oxide, and leaded zinc oxide. It is also used in large quantities as an inert filler in rubber goods, paper, linoleum, oilcloth, and in window-shade cloth. As a rule lithopone is not extensively used in outside paints because of the property of darkening when exposed to sunlight. In recent years there have been placed on the market brands of lithopone which are said to withstand exposure to sunlight.

DOMESTIC PRODUCTION.

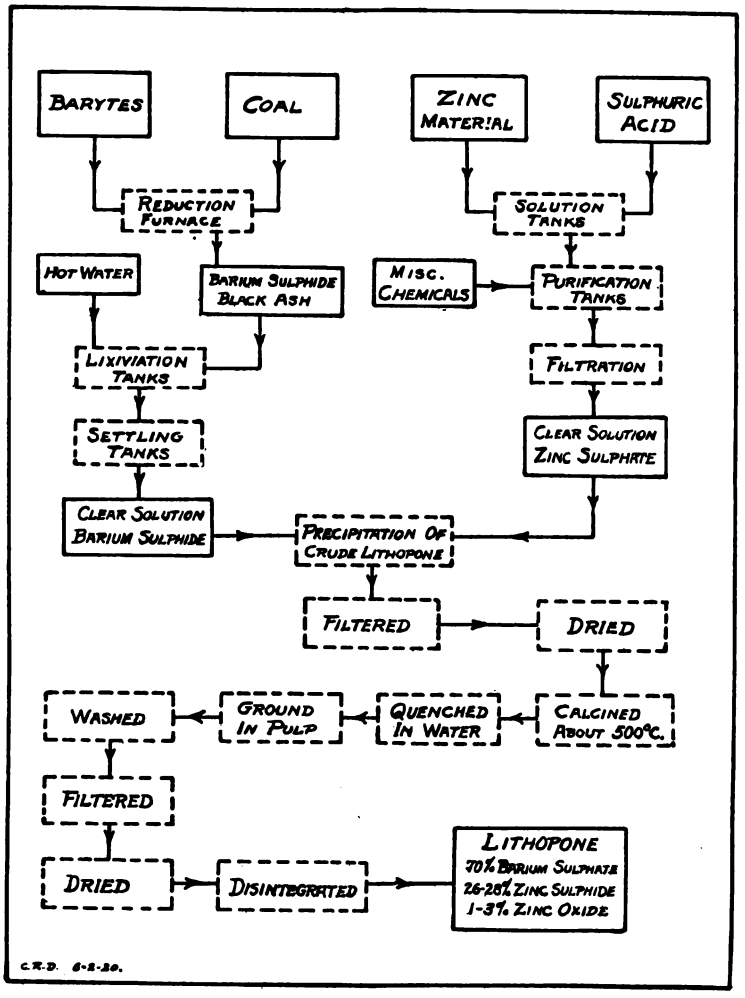
Raw materials.—The basic raw materials necessary for the manufacture of lithopone are crude barytes, coal or coke, zinc, and sulphuric acid. Other chemicals are required in the process of manu facture, but in minor quantities. Large quantities of clear, soft water are required in making up the solutions of materials and in the washing of the lithopone to remove soluble impurities. Of these materials, this report is especially concerned with crude barytes. The other basic raw materials are available from domestic sources, and, with the exception of zinc, present no special tariff problem.

The barytes requirements of lithopone manufacturers prior to the war were supplied wholly by imports, chiefly from Germany. The entire lithopone industry was then located along the Atlantic coast, at or within a short distance of tidewater. Under these conditions crude barytes could be imported at a cost of about $5.20 per short ton, delivered at plant, which was less than the price at which domestic barytes could be purchased. The stoppage of imports of crude barytes from Germany as a result of war conditions forced the lithopone manufacturers to seek a domestic supply. This condition and the establishment of a barium chemical industry was responsible for the domestic development of crude barytes production in the southern district, as previously described. (See p. 21.) It is reasonably certain, with restoration of normal competitive conditions and under existing tariff duties (15 per cent ad valorem) on crude barytes, that lithopone manufacturers located along the Atlantic coast will return to imports as the source of their barytes requirements. Regardless of a duty, the lithopone manufacturers located in the Middle West will use chiefly crude barytes from the Missouri district. The relation of the cost of crude barytes to the total cost of manufacturing lithopone is shown on page 87. From this it is possible to calculate the effect of an increase or decrease in the cost of crude barytes on the cost of lithopone, other factors remaining fixed.

Process of manufacture.—The manufacture of lithopone requires the preliminary production of a solution of barium sulphide and a solution of zinc sulphate. The preparation of barium sulphide by roasting barytes with coal has already been described. (See p. 44.) The zinc sulphate solution is prepared by dissolving some form of zinc (zinc ash, scrap, skimmings, spelter, or roasted ore) in dilute sulphuric acid. Since the zinc materials used contain, as a rule, other metals as impurities (chiefly iron, copper, or cadmium), which would form colored products on treatment with barium sulphide, it is necessary to purify thoroughly the zinc sulphate solution. Various chemicals are used at this point for purification of the zinc

FIGURE 4.—DIAGRAM OF THE MANUFACTURE OF LITHOPONE

Solid lines——Raw, intermediate, or finished products
Broken lines- - - -Apparatus, or steps in process



sulphate solution, which is one of the most important steps in the manufacture and requires careful chemical control.

Crude lithopone is now precipitated from the purified zinc sulphate solution as a white insoluble substance by adding a hot solution of barium sulphide. The crude lithopone is filtered from the solution, then dried, and calcined in a muffle furnace at about 500° C., which may or may not utilize waste heat from the roasting of the barytes with coal. The hot product from the furnace is thrown into water ("quenching"), ground in pulp, washed several times with water to remove soluble impurities, filtered, and dried. The dry lithopone is run through a disintegrator, which breaks it up into a fine powder, and it is then packed in bags or barrels for shipment. In some cases the lithopone is air floated to insure a uniformly fine product before packing. The process of manufacturing lithopone is shown graphically in Figure 4.

Production and consumption.—The production of lithopone in the United States has shown a rapid growth during the last 10 years. From 1910 to 1919 the production increased nearly sixfold, or from 25,330,000 pounds to about 145,000,000 pounds. During this period the domestic output of lithopone has supplied from 84 to 100 per cent of the total consumption. There has been relatively little competition from imported lithopone. The growth of the lithopone industry can be attributed to the increased utilization of this commodity and the natural growth of the consuming industries during the last 10 years. Although exports of lithopone are not shown separately in Commerce and Navigation, it is known that a fairly large export trade has developed in lithopone during 1920.

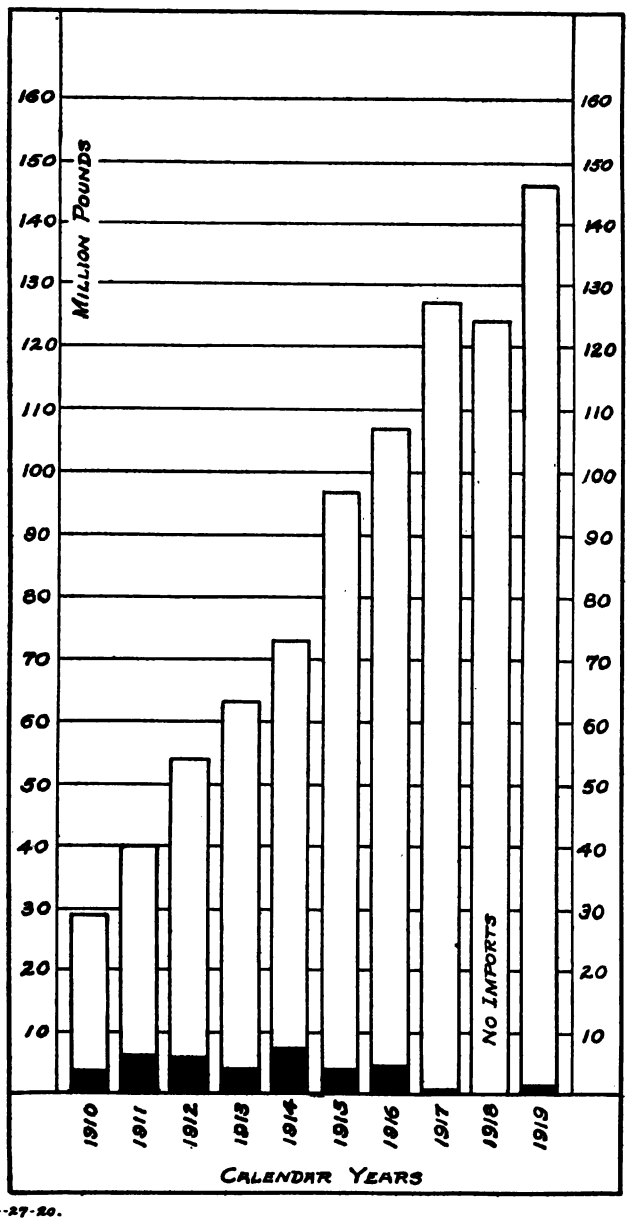
Table 23 shows the figures for the production, importation, and consumption of lithopone in this country from 1910 to 1919, inclusive. Figure 5 shows graphically the relation of imports and production of lithopone to the total consumption in the United States.

TABLE 23.—*Production and consumption of lithopone in the United States.*

Calendar year.	Production.[1]			Imports.[2]		Consumption.
	Quantity.	Value.	Per cent of consumption (quantity).	Quantity.	Value.	
	Pounds.			*Pounds.*		*Pounds.*
1910	25,330,000	$916,512	87.1	3,726,135	$99,954	29,056,135
1911	33,732,000	1,243,108	84.1	6,355,312	166,199	40,087,312
1912	48,440,000	1,702,119	89.1	5,904,475	153,303	54,344,475
1913	59,370,000	2,170,445	93.6	4,054,423	122,063	63,424,423
1914	65,638,000	2,490,530	89.7	7,544,148	259,955	73,182,148
1915	92,988,000	3,760,472	95.8	4,087,826	137,816	97,075,826
1916	102,582,000	5,798,927	95.6	4,681,560	405,730	107,263,560
1917	127,426,000	7,394,531	99.6	448,000	29,199	127,874,000
1918	124,806,000	7,923,209	100.0	.....	.....	124,806,000
1919	145,000,000	.....	99.0	1,477,296	122,708	146,477,296

[1] 1910 to 1918, inclusive, from Mineral Resources, U. S. Geological Survey. 1919 from reports submitted to the Tariff Commission by individual manufacturers.
[2] From 1910 to Oct. 3, 1913, listed as "white sulphide of zinc."

FIGURE 5.—CONSUMPTION OF LITHOPONE IN THE UNITED STATES, 1910–1919



Geographical distribution.—The domestic lithopone industry, prior to the war, was confined to the Atlantic coast district. Most of the plants were located at tidewater and were thus favorably situated as regards the supply of the raw material, barytes, imported from Germany. According to the Geological Survey there were in 1914 three manufacturers in New Jersey, two in Pennsylvania, and one in Delaware. The Geological Survey reported production of lithopone during 1915 at Chicago by the Midland Chemical Co. This marked the beginning of the lithopone industry in the Middle West and the utilization of local barytes in the manufacture of this paint pigment. There has since been considerable development of the lithopone industry in the Middle West. At the present time there are two manufacturers located in the Chicago district and two in the St. Louis territory. On the basis of the 1919 production about 80 per cent of the lithopone is produced in the Atlantic coast district.

The manufacturers of lithopone, their office addresses, and location of plants are as follows:

E. I. du Pont de Nemours & Co., Wilmington, Del. (Plants at Philadelphia, Pa., Camden and Newark, N. J.)

Krebs Pigment & Chemical Co., Newport, Del. (Plant same address.)

Chemical Pigments Corporation, 617 Stock Exchange Building, Philadelphia, Pa. (Plant at St. Helena, Baltimore, Md.)[1]

Midland Chemical Co., 208 South La Salle Street, Chicago, Ill. (Plant at Argo, Ill.)

New Jersey Zinc Co., 160 Front Street, New York. (Plant at Palmerton, Pa.)

Grasselli Chemical Co., Cleveland, Ohio. (Plant at Grasselli, N. J.)

Sherwin-Williams Co., Cleveland, Ohio. (Plant at Kensington, Ill.)

Butterworth-Judson Corporation, 61 Broadway, New York. (Plant at Newark, N. J.)

Mineral Refining & Chemical Corporation, St. Louis, Mo. (Plant at St. Louis, Mo.)

Collinsville Zinc Corporation, St. Louis, Mo. (Plant at Collinsville, Ill.)

FOREIGN PRODUCTION.

Little information is available as to the size of the lithopone industry in foreign countries. It is known that the principal producers are Germany and Belgium. Table 24 shows Germany's exports and imports of lithopone prior to the war.

TABLE 24.—*Germany's exports and imports of lithopone, 1909–1913.*

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

Year.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
1909	8,337	$450,436	2,736	$141,967
1910	11,639	503,078	3,684	159,118
1911	15,148	730,559	3,003	129,819
1912	16,825	793,206	3,676	174,839
1913	19,326	950,180	3,405	176,506

[1] Purchased in June, 1920, by the Glidden Co., Cleveland, Ohio.

IMPORTS INTO THE UNITED STATES.

From 1911 to 1916, inclusive, the imports of lithopone were fairly constant at 5,000,000 to 6,000,000 pounds annually with the exception of 1914 when the imports were a little over 8,000,000 pounds. The average dutiable value of lithopone during this period was from 2.5 to 3.1 cents a pound except in 1916 when the price increased to 8.1 cents a pound. In 1917 the imports decreased sharply and during 1918 and 1919 remained between 230,000 and 450,000 pounds a year. Imports of lithopone have supplied only a small portion of the domestic consumption of lithopone. Table 25 shows the imports for consumption of lithopone from 1910 to 1919, inclusive.

TABLE 25.—*Imports of lithopone for consumption in the United States 1910–1919.*[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	1½ cents per pound	2,307,699	$68,925	$28,846	$0.029	41.85
1911	do	5,409,520	145,201	67,619	.027	46.57
1912	do	6,325,072	157,921	79,063	.025	50.07
1913	do	5,163,642	144,812	64,545	.028	44.57
1914 [2]	do	847,563	25,777	10,594	.030	41.10
1914 [3]	15 per cent	7,245,151	218,133	32,719	.030	15.00
1915	do	6,185,245	195,828	29,374	.031	15.00
1916	do	5,122,083	414,573	62,185	.081	15.00
1917	do	231,869	20,591	3,088	.089	15.00
1918	do	448,000	29,199	4,379	.065	15.00
1919	do	233,338	17,678	2,652	.076	15.00

[1] From 1910 to Oct. 3, 1913, listed as "white sulphide of zinc."
[2] July 1 to Oct. 3, 1913, under act of 1909.
[3] Oct. 4, 1913, to June 30, 1914, under act of 1913.

PRICES.

Domestic.—The price of lithopone from 1912 to 1915 was constant at about 3¾ cents a pound. The price increased to a maximum of 14½ cents a pound in the second and third quarters of 1916. During 1917, 1918, and 1919 the price ranged from 6 to 8 cents a pound, an average of about double the prewar price. The price on July 3, 1920, was 7¾ cents a pound in bags and 8–8¼ cents a pound in barrels, car lots. Table 26 shows the general trend of the price of lithopone as quoted by the Oil, Paint and Drug Reporter.

TABLE 26.—*Prices of lithopone, spot quotation, New York market.*

[Cents per pound.]

First of month.	1912	1913	1914	1915	1916	1917	1918	1919
January	3¾–4	3¾–4½	3¾–4½	3¾–4½	6½–7	6½–6½	6½–7	7¾–8¼
April	3¾–4	3¾–4½	3¾–4½	4¼–4¾	14½–15½	6½–6½	7 –8½	[1] 6½
July	3¾–4	3¾–4½	3¾–4½	6	14½–15½	6¼–6½	7½–8½	6½
October	3¾–4½	3¾–4½	3¾–4½	5¾–6½	8½–10	6 –6½	8 –8½	7

[1] Listed from here on as lithopone, in barrels, car lots.

Foreign.—The following prices fixed by the Association of German Lithopone Manufacturers for export countries were received by the Commission from a reliable source. The prices apply for the last half of 1919.

TABLE 27.—*Prices of 30 per cent lithopone (per 100 kilos) fixed by German manufacturers for export.*[1]

France, Belgium, Luxemburg, and the Levante	francs	108
Switzerland and Italy	Swiss francs	75
Spain and Portugal	pesetas	70
Holland	florins	37
Scandinavia	kroner	62
America	dollars	13
England, South America, Japan, and other oversea countries not otherwise specified	pounds sterling	[2]33

The price to the United States of $13 per 100 kilograms is equivalent to 5.72 cents a pound f. o. b. Rotterdam with the discount deducted. The price prevailing in the United States during the last half of 1919 was 6½ to 7 cents a pound.

TARIFF HISTORY.

The term "lithopone" did not appear in the tariff law until the act of 1913, when, in paragraph 61, "lithopone and white sulphide of zinc" were provided for with a duty of 15 per cent ad valorem. Under the act of 1890 lithopone was dutiable as "white paint containing zinc, but not containing lead; dry" at 1¼ cents per pound (Gabriel *v.* United States, 65 Fed., 422; G. A. 1319, T. D. 12670), and under the act of 1897 as "sulfid of zinc white, or white sulphide of zinc," at 1¼ cents a pound (Gabriel *v.* United States, 123 Fed., 296). This duty during the fiscal years 1910 to 1913, inclusive, was equivalent to from 42 to 50 per cent ad valorem.

[1] All these prices are subject to 3 per cent discount or rebate for 25 ton orders and upward and are packed in free casks of 250 kilos net with a negligible extra for smaller packages. Delivered Rotterdam or frontier stations.

[2] Per English ton.

COSTS OF PRODUCTION IN THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES, 1919

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COSTS OF PRODUCTION IN THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES, 1919.

Summary of Costs.

Representatives of the Tariff Commission held conferences in New York, Washington, and St. Louis with producers and manufacturers, who agreed to submit their costs of production to the Commission on their own cost forms. These cost reports, after tabulation and study, were verified by comparison with the books of the companies by members of the Commission's staff.

The averages of costs as shown in the tables presented are in all cases weighted averages, based on the actual production of the companies reporting. In no case has a simple average been used in presenting costs. For example, the average cost of lithopone for 1919 has been obtained by dividing the sum of the total cost of all companies by the aggregate production of all companies. This method obviously gives more weight in the average to the costs of a company with a large production than to the costs of a company with a small production. It is believed that the weighted average costs, as given, are representative of conditions in the industries as a whole.

The cost of mining crude barytes in western mines increased from $5.30 per short ton in 1916 to $7.74 in 1919, while the increase in southern mines was from $3.89 to $7.39 per short ton. This corresponds to an increase of 90 per cent for southern mines and 46 per cent for western mines. The cost of manufacturing ground barytes was $11.21 per short ton in 1914; $12.69 in 1916; and $19.25 in 1919, an increase of about 70 per cent from 1914 to 1919. The cost of producing barium chemicals during 1919 was $0.0294 per pound for blanc fixe; $0.0316 per pound for barium carbonate; $0.0539 per pound for barium chloride, and $0.197 per pound for barium peroxide. The average cost of manufacturing lithopone during 1919, as reported by 11 plants, was $0.0602 per pound. Of this total cost 43 per cent was due to material; 18 per cent to labor; 34 per cent to overhead; and 5 per cent to sales expense. The apparent profit of the industry was $0.0065 per pound of lithopone produced. The rela-

tion of crude barytes to the lithopone industry is shown by the fact that about 14 per cent of the total factory cost of lithopone was due to barytes. Zinc is the most expensive material entering into lithopone and amounted to about 22 per cent of the total factory cost. The average factory cost was $0.0571 per pound of lithopone.

Cost of Mining Barytes, 1916 and 1919.

INTRODUCTORY.

The costs of mining barytes during 1916 and 1919, as presented in the following pages, are separated for western and southern mines because of the different methods of mining used. (See p. 24.) In western mines the methods of keeping costs are as a rule inadequate, except in the case of the larger firms. The information submitted by smaller operators has been accepted, although in some cases accurate records were not available for purposes of complete verification. In such instances, however, the costs submitted agreed closely with those of larger operators, whose costs were checked to their books, and therefore they have been included in the following tables. The cost records of southern mines were found to be in better condition than those of western mines. A large part of the mining in the southern district is done by large consumers of crude barytes, who keep accurate records. There was, however, very little uniformity in the detail of costs submitted by the various companies.

The outstanding difference in costs as reported by companies in both mining districts was in the charge for amortization of investment due to depletion of ore body and in royalties paid owners of the property for mining privileges. In many cases no charge was reported. As it would be manifestly unfair to include a charge for amortization in one case and not in another, a total cost based on a uniform charge for amortization and royalties for all companies has been shown in the tables of costs of mining barytes. It has seemed feasible to use uniformly the weighted average of the charges reported. In a few cases where charges reported as amortization appeared excessive on account of being based on a short period, they were not used in arriving at the uniform charge.

The costs as given for barytes in all cases are the costs on board cars for shipment. This seemed a more desirable basis for comparison between districts, because this cost plus freight rates gives the cost of crude barytes delivered at any point in the United States. The costs, therefore, as given include hauling, weighing, and loading in the case of the western mines and switching or hauling charges in the case of the southern mines.

COMPARISON OF COSTS IN WESTERN AND SOUTHERN MINES.

TABLE 28.—*Comparison of total cost of mining barytes in western and southern mines during 1916 and 1919.*

[Per short ton.]

1	2	3	4	5
Year.	Cost in western mines.		Cost in southern mines.	
	As reported.	On uniform amortization and royalty basis.	As reported.	On uniform amortization and royalty basis.
1916	$5.30	$5.96	$3.89	$3.89
1919	7.74	7.97	7.39	6.31

Table 28, which compares the costs in the western and southern mines, shows that the cost of production during 1916 and 1919 was lower in the southern than in the western mines. In 1916 the difference in the costs "as reported" (columns 2 and 4) was $1.41 per short ton. On a basis of uniform amortization and royalties (columns 3 and 5) the difference was even greater and amounted to $2.07 per short ton. This is due to the fact that in only a few cases did western mines report a charge for amortization or royalties. In 1919 the difference in costs between the two districts was considerably less. The costs "as reported" in 1919 showed a difference of $0.35 per short ton, and on the basis of "uniform amortization and royalties" a difference of $1.66 per short ton in favor of the southern mines.

Table 28 also shows that the increase in the cost of producing barytes from 1916 to 1919 "as reported" was much greater in case of the southern mines than the western mines. The total average cost in southern mines increased from $3.89 per short ton in 1916 to $7.39 in 1919, or an increase of 90 per cent. The average cost in the western mines increased from $5.30 per ton in 1916 to $7.74 per ton in 1919, or an increase of about 46 per cent. On a basis of "uniform amortization and royalties" the costs in western mines increased about 33 per cent and in southern mines by about 62 per cent during this period.

A study of costs in western and southern mines reveals a considerable difference in labor charge per ton of barytes. This is to be expected from the methods used in the two districts. The western deposits are worked by pick and shovel and require more labor, while the southern deposits are mined by steam shovels. In 1916 the cost of labor in western mines was $2.37 per ton as compared with $1.62 per ton for southern mines, or a difference of $0.75 per ton.

In 1919 the charge for labor in western mines was $4.38 as against $2.82 in southern mines, or a difference of $1.56 per ton. The labor per ton of ore in western mines increased about 85 per cent from 1916 to 1919, while in southern mines there was an increase of 74 per cent. The difference in labor per ton of ore mined in favor of southern mines is in part offset by larger overhead charges, due to necessary investment in mining equipment.

COSTS IN WESTERN MINES.

The methods of mining and conditions in the western fields are unique. Practically all of the mining is done by individuals on a tonnage basis. Each miner is paid a certain rate per ton of ore mined. Other charges are on the same basis. The prices paid for ore delivered at the loading platform at the shipping point are fairly uniform. The price paid for hauling to the shipping point varies with the distance. The miner receives the difference. In other words, the net price received per ton of ore by miners located close to the railroad is greater than that received by miners some distance from the railroad. This condition results in most of the mining being done close to the railroad. A large part of the mining is on property owned by consumers of crude barytes. These companies permit miners to work the property, and they usually furnish the miners with housing free of charge as an inducement to keep them on the property.

TABLE 29.—*Cost of mining barytes in western mines during 1916, by companies.*

[Per short ton.]

1	2	3	4	5	6	7	8
Company No.	Total cost.		Detail of total cost as reported (column 2).				
	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Transportation to shipping point.	Weighing and loading.	Amortization and royalties.	Other expenses.
1	$6.17	$6.25	$2.36	$1.98	$0.35	$0.97	$0.51
2	6.30	6.10	3.00	1.50	.25	1.25	.30
3	6.75	7.80	1.50	4.00	.25	.....	1.00
4	3.80	4.85	2.70	.80	.19	.....	.11
Weighted average cost....	5.30	5.96	2.37	1.87	.25	{ .39 [1] 1.05 }	.42

[1] Uniform charge for amortization and royalties used in arriving at total cost in column 3.

Table 29 shows the cost of mining barytes by western mines during 1916 by companies. The total weighted average cost "as reported" of $5.30 per ton is made up of the following charges: $2.37

for labor in mining, or 45 per cent; $1.87 for transportation to shipping point, or 35 per cent, and $0.25 for weighing and loading, or 4.7 per cent. Amortization and royalties were reported by only two firms and are the only charges for these items included in the total average cost of $5.30. By applying a uniform charge for amortization and royalties ($1.05), which was the weighted average of the two charges reported, the average costs for each firm, as shown in column 3, were obtained. This method increases the average cost as reported by $0.69 per ton, or 13 per cent.

TABLE 30.—*Cost of mining barytes in western mines during 1919, by companies.*

[Per short ton.]

1	2	3	4	5	6	7	8
Company No.	Total cost.		Detail of total cost as reported (column 2).				
	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Transportation to shipping point.	Weighing and loading.	Amortization and royalties.	Other expenses.
1	$7.66	$7.47	$4.56	$2.01	$0.13	$0.96	.....
2	9.45	10.22	2.50	5.35	.30	.....	$1.30
3	7.00	7.77	5.88	1.00	.12	.....	.....
4	8.50	8.77	2.00	6.00	.....	.50	.....
5	8.03	7.09	3.20	2.48	.17	1.71	.47
6	8.82	9.59	5.60	1.40	.80	.....	1.02
7	7.80	8.57	6.00	1.40	.30	.....	.10
8	8.00	7.27	4.50	1.50	.25	1.50	.25
9	8.10	8.87	5.00	1.60	.30	.....	1.20
10	7.59	7.76	3.77	2.01	.17	.60	1.04
Weighted average cost	7.74	7.97	4.38	2.01	.20	{ [1] .54 .77 }	.61

[1] Uniform charge for amortization and royalties used in arriving at total cost, column 3.

Table 30, identical with Table 29, except that the costs given are for the year 1919, shows a total weighted average cost for 1919 "as reported" by 10 companies of $7.74 per short ton. By applying a uniform charge for amortization and royalties the total average cost was increased to $7.97 per short ton, or by about 3 per cent. The total average cost "as reported" is made up of the following charges: Labor in mining of $4.38 per short ton, or 56.5 per cent; transportation to shipping point of $2.01 per short ton, or 26 per cent; weighing and loading of $0.20 per ton, or 2.6 per cent; amortization and royalties of $0.54 per ton, or 7 per cent; and other expenses of $0.61 per ton, or 7.9 per cent. The total cost as shown in column 3 is based on a uniform charge for amortization and royalties, which was $0.77 per short ton, or the weighted average of all firms reporting a charge for amortization and royalties as shown in column 7.

This method increased the cost as reported by all companies, with the exception of three firms.

The charge for "labor in mining," as shown in column 4, is the charge which was reported by the various companies, with the exception of companies 1 and 10. These two firms reported labor in mining and transportation to shipping point combined. The weighted average charge as reported by all other companies for transportation to shipping point has been applied to costs of these two firms, in order to arrive at a figure for labor in mining. As shown by column 4, the labor in mining varied between companies from $2 per ton to $6 per ton. This variance in cost of labor is offset by the charge for transportation as shown in column 5. The transportation charge varied from $1 per ton to $6 per ton. Wherever a high charge for labor is reported a low transportation charge is usually given. The cost delivered at shipping points, or the sum of columns 4 and 5, is fairly uniform, because of existing conditions which have previously been discussed. (See p. 66.) The transportation costs as given are those reported by the various companies, with the exception of companies 1 and 10, as noted above.

Column 6 shows the charge for weighing and loading the crude barytes on board cars, which was reported by all firms but one—company 4. This charge shows a variation from $0.12 per ton to $0.80 per ton. Column 7 shows the amortization and royalties as reported by 5 of the 10 companies. This charge ranged from $0.50 per ton to $1.71 per ton. The weighted average for the five companies reporting was $0.77 per ton, and was used in arriving at the total cost in column 3. The average charge of $0.54 per ton is the total of charges for amortization and royalties divided by the total production of all firms, and was used in arriving at the total cost "as reported" shown in column 2. Column 8 shows other expenses charged to cost of mining barytes. Under this heading are included such overhead items as administration, housing furnished miners, and losses in weight during shipping.

COSTS IN SOUTHERN MINES.

The costs of mining barytes, as shown for southern mines, include companies operating in the Sweetwater, Tenn., and Cartersville, Ga., districts. Only three firms were able to report costs for 1916, because the industry was developed in this district as a result of war conditions, and at this stage of the development little attention was given to cost records. The costs of the companies reporting, however, may be taken as representative for the year 1916. In 1919 the industry in these districts was more fully developed and costs were reported by 12 companies.

TABLE 31.—*Costs of mining barytes in southern mines during 1916, by companies.*

[Per short ton.]

1	2	3	4	5	6
Company No.	Total cost (as reported).	Labor in mining.	Supplies in mining.	Amortization and royalties.	Other expenses.
1	$4.00	$1.25	$0.10	$0.50	$2.15
2	3.71	1.29	.25	1.51	.66
3	4.08	2.29	.....	.25	1.54
Weighted average cost	3.89	1.62	.14	.90	1.23

Table 31 shows the cost of mining barytes by southern mines during 1916. The total weighted average cost "as reported" was $3.89 per short ton, and is made up of $1.62 for labor in mining, or 41.7 per cent; $0.14 for supplies in mining, or 3.6 per cent; $0.90 for amortization and royalties, or 23.1 per cent; and $1.23 for other expenses, or 31.6 per cent. A charge for supplies in mining (column 4) was reported by only two of the three firms, and was $0.10 per ton in one case and $0.25 per ton in the other. Since an amortization and royalty charge was shown by all firms and the charge appeared reasonable, it was not necessary to apply a uniform amortization and royalty charge to the costs.

TABLE 32.—*Costs of mining barytes in southern mines during 1919, by companies.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.		Detail of Total Cost as reported (Column 2).			
	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Supplies in mining.	Amortization and royalties	Other expenses.
1	$6.85	$6.48	$2.50	$0.15	$1.00	$3.20
2	12.25	12.21	5.88	2.67	.67	3.03
3	10.92	11.10	6.05	2.37	.45	2.05
4	10.93	4.92	2.53	.97	6.64	.79
5	5.16	5.06	4.02	.....	.73	.41
6	6.58	6.32	3.34	.50	.89	1.85
7	5.80	5.05	2.14	.03	1.38	2.25
8	5.24	5.87	1.06	.....	.....	4.18
9	8.64	9.27	3.62	.42	.....	4.60
10	9.77	9.54	6.63	.47	.86	1.81
11	7.06	7.44	3.90	.....	.25	2.91
12	6.82	7.45	3.03	1.13	.....	2.66
Weighted average cost	7.39	6.31	2.82	.46	{ 1.71 [1] 0.63 }	2.40

[1] Uniform charge for amortization and royalties used in arriving at the total cost in column 3.

Table 32 shows the cost of mining barytes in southern mines during 1919, as reported by 12 companies. The total weighted average cost, "as reported" (column 2), was $7.39 per short ton, and is made up of the following charges: $2.82 for labor in mining, or 38.2 per cent; $0.46 for supplies in mining, 6.2 per cent; $1.71 for amortization and royalties, or 23.2 per cent; and $2.40 for other expenses, or 32.4 per cent. Column 3 shows the total cost of mining barytes on the basis of a uniform amortization and royalty charge. The total weighted average cost on this basis is $6.31 per short ton, or a decrease of $1.08 per ton, or 14.6 per cent from the total average cost, "as reported." The uniform charge used in arriving at this total cost was $0.63 per ton. This charge was arrived at by taking the weighted average of the amortization and royalty charges shown in column 6, with the exception of certain charges which were omitted. Column 7 shows other expenses charged by the various companies to cost of mining barytes during 1919, which include charges for administration, power, and other overhead expenses.

Cost of Manufacturing Ground Barytes, 1914, 1916, and 1919.

INTRODUCTORY.

The cost of manufacturing ground barytes, as shown, includes companies operating plants both in the southern and western districts. It was impossible to compare costs between the two districts on account of the small number of manufacturers. In compiling the costs on ground barytes the Commission found that the various companies kept detailed cost records. There was very little uniformity, however, in the detail of the costs, as reported.

It should be pointed out that the company numbers used in presenting costs of ground barytes do not necessarily represent the same company for all years. For example, costs given as those of company 1 during 1914, 1916, and 1919 are not directly comparable as those of the same firm.

COMPARISON OF COSTS FOR 1914, 1916, AND 1919.

Table 33.—*Comparison of costs of manufacturing ground barytes during 1914, 1916, and 1919.*

[Per short ton.]

1	2	3	4		5		6		7	
Year.	Total cost.	Factory cost.							Selling expenses.	
		Total.	Material.		Labor.		Overhead.			
			Cost.	Per cent of total cost.	Cost.	Per cent of total cost.	Cost.	Per cent of total cost.	Cost.	Per cent of total cost.
1914.....	$11.21	$10.61	$6.13	54.7	$1.30	11.6	$3.18	28.4	$0.60	5.3
1916.....	12.69	11.98	8.08	63.7	1.08	8.5	2.82	22.2	.71	5.6
1919.....	19.25	18.63	10.68	55.5	2.47	12.8	5.48	28.5	.62	3.2

Table 33 compares the total average cost of manufacturing ground barytes during 1914, 1916, and 1919, and the percentage of the total cost due to the various items of cost. Column 2 shows that the total cost increased from $11.21 in 1914 to $19.25 in 1919. The total cost, as given in column 2, is the sum of the total factory cost in column 3 and selling expense in column 7. Column 3 shows that the total

factory cost increased from $10.61 in 1914 to $18.63 in 1919. This increase is in practically the same ratio as the total cost, since the selling expense during the different years was practically uniform at between $0.60 and $0.71 per ton, as shown in column 7. Column 4 shows that the material charge varied from $6.13 in 1914 to $10.68 in 1919. The charge for material is the principal cost item entering into the total cost of ground barytes and amounted to between 55 and 65 per cent of the total factory cost. Column 5 shows the labor charges per ton of ground barytes, which decreased from $1.30 per ton in 1914 to $1.08 in 1916 and then increased to $2.47 per ton in 1919. Labor accounted for 8.5 to 13 per cent of the total cost. Column 6 shows that the overhead expense decreased from $3.18 in 1914 to $2.82 in 1916 and then increased to $5.48 in 1919. Overhead expense was 22 to 29 per cent of the total cost. Selling expense was between 3 and 5.5 per cent of the total cost.

DETAIL OF COSTS OF GROUND BARYTES, BY COMPANIES.

TABLE 34.—*Cost of manufacturing ground barytes, by companies, during 1914.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$12.09	$11.57	$5.65	$1.88	$4.04	$0.52
2	10.51	9.88	6.43	.74	2.72	.63
3	12.49	11.89	6.16	2.13	3.60	.60
4	11.74	11.14	5.72	2.08	3.34	.60
Weighted average cost	11.21	10.61	6.13	1.30	3.18	.60

Table 34 shows the cost of manufacturing ground barytes by companies during 1914. Column 2 shows that the total weighted average cost as reported by four companies during 1914 was $11.21 per short ton. The total average cost was made up of the following charges: $6.13 per ton for material, or 54.7 per cent; $1.30 per ton for labor, or 11.6 per cent; $3.18 per ton overhead charges, or 28.4 per cent; and $0.60 per ton for selling expenses, or 5.3 per cent.

The total factory cost shown in column 3 is made up of the items material, labor, and overhead. The average factory cost of the four companies reporting was $10.61 per ton. Companies 1 and 2 were the only firms that reported selling expense (column 7). The weighted average of these two firms was taken as the average selling expense and substituted for companies 3 and 4 in arriving at the total cost in column 2 for these two firms.

TABLE 35.—*Cost of manufacturing ground barytes, by companies, during 1916.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$15.69	$14.99	$9.63	$1.11	$4.25	$0.70
2	11.49	10.77	8.00	.54	2.23	.72
3	12.43	11.72	6.28	2.05	3.39	.71
4	13.24	12.53	7.58	2.07	2.88	.71
Weighted average cost	12.69	11.98	8.08	1.08	2.82	.71

Table 35 shows the cost of manufacturing ground barytes by companies during 1916. Column 2 shows that the average cost of the four companies was $12.69. The average cost is made up of a charge of $8.08 for material, or 63.7 per cent; $1.08 for labor, or 8.5 per cent; $2.82 for overhead, or 22.2 per cent; and $0.71 for selling expenses, or 5.6 per cent. Column 3 shows that the total average factory cost was $11.98. The selling expenses as reported by companies 1 and 2 was $0.70 and $0.72 per ton, respectively. The weighted average of these two charges, or $0.71, was inserted as the selling expenses for companies 3 and 4, and was used in arriving at the total cost shown in column 2 for these two companies.

TABLE 36.—*Cost of manufacturing ground barytes, by companies, during 1919.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$25.61	$24.73	$12.50	$3.00	$9.23	$0.88
2	19.07	18.10	11.59	1.26	5.25	.97
3	14.51	13.89	7.40	3.26	3.23	.62
4	19.54	19.35	10.74	3.08	5.53	.19
Weighted average cost	19.25	18.63	10.68	2.47	5.48	.62

Table 36 shows the cost of ground barytes during 1919 as reported by four companies. The total weighted average cost (column 2) was $19.25 per ton. This total cost was made up of the following charges: $10.68 per ton for material, or 55.5 per cent; $2.47 for labor, or 12.8 per cent; $5.48 for overhead, or 28.5 per cent, and $0.62 for selling expenses, or 3.2 per cent. The total factory cost, as shown in column 3, averaged $18.63 per ton. During 1919 all companies reported

separately a charge for selling expenses, with the exception of No. 3, which firm included selling under overhead. The weighted average of the three firms separately reporting a charge was inserted for company 3, and subtracted from that company's overhead as reported and from total cost shown in column 2 to obtain the total factory cost. The average selling expense of the three companies reporting was $0.62 per short ton.

TABLE 37.—*Details of overhead charged to ground barytes, 1919.*

[Per short ton.]

1	2	3	4	5
Company No.	Total overhead.	Works expense.	Fixed charges.	Administration.
1	$9.23	$7.45	$0.58	$1.20
2	5.25	2.29	2.54	.42
3	3.23	2.92	.....	.31
4	5.53	5.07	.....	.46
Weighted average	5.48	4.03	.....	.50

The detail in which overhead charges for ground barytes were reported varied greatly. Therefore the total overhead is the only fair basis of comparison between companies. The overhead during 1919 as reported by the four companies manufacturing ground barytes is given in Table 37 in as much detail as was possible. Although not directly comparable by companies, the table shows the detail to which overhead was distributed. The total overhead as shown in column 2 varied between companies from $3.23 to $9.23 per short ton of ground barytes produced.

Column 3 shows the total of the items charged to works expense, which includes such items of cost as operating and miscellaneous supplies, repairs, coal or electric power, packages, and other general plant expense. Works expense is seen to be the largest overhead charge, and averaged $4.03 per short ton, or about 70 per cent of the total overhead. Column 4 shows fixed charges as reported by only two companies. This heading includes insurance, State and local taxes, and depreciation. Only one firm reported a charge for depreciation. Column 5 shows administration expense as reported by all companies. This heading includes salaries for factory superintendence and office expense and salaries. Administration expense averaged $0.50 per short ton, or about 10 per cent of the total overhead.

Costs of Manufacturing Barium Chemicals, 1919.

INTRODUCTORY.

Before discussing the costs of barium chemicals the Commission desires to point out the lack of adequate cost-finding methods found to be prevalent in the barium chemical industry. The Commission does not wish to convey the impression that all companies manufacturing barium chemicals do not keep accurate cost records, but a number of the firms engaged in this industry lack adequate methods of cost accounting, and the data obtained from the records of these companies are at best an approximation of the true cost. This condition may be accounted for by the fact that the industry was developed under stress of war conditions, with emphasis on output rather than on economy of operation and on accurate cost records. Now that the industry is approaching more stabilized conditions, more attention should be given to cost accounting by those firms which now have inadequate methods. The Commission emphasizes the fact that some of the manufacturers of barium chemicals have adequate cost systems, and had this condition uniformly prevailed the cost investigation would have been greatly facilitated. From the information available the Commission is able to present the following costs of barium chemicals, and believes that the costs given may be taken as representative of the industry.

COMPARISON OF COSTS OF BARIUM CHEMICALS.

TABLE 38.—*Cost of manufacturing barium chemicals during 1919.*

[Per pound.]

Name of product.	Manufacturers reporting.	Total cost.	Material.		Labor.		Overhead and selling expense.	
			Cost.	Per cent of total.	Cost.	Per cent of total.	Cost.	Per cent of total.
Barium carbonate....	3	$0.0316	$0.0167	52.9	$0.0038	12.0	$0.0111	35.1
Barium peroxide.....	3	.197	.088	44.7	.046	23.3	.063	32.0
Blanc fixe[1].....	3	.0294	.0160	54.4	.0028	9.5	.0106	36.1
Barium chloride.....	4	.0539	.0218	40.5	.0109	20.2	.0212	39.3

[1] Precipitated barium sulphate.

Table 38 shows the weighted average costs of four barium chemicals—barium carbonate, barium peroxide, barium chloride, and blanc fixe or precipitated barium sulphate. This table also shows the

total cost distributed to the three items—material, labor, and overhead. The Commission is unable to publish costs submitted on other barium chemicals without disclosing the costs of the one or two firms reporting. The barium chemicals for which costs are given are, however, the most important, and include all barium chemicals mentioned by name in the tariff act of 1913. The costs of these may be taken as representing conditions in the industry.

It has been necessary, because of the form in which costs were kept by the companies, to combine overhead and selling expenses. In all cases selling expense is included, with the exception of one firm manufacturing barium chloride. Depreciation on plant and equipment is included in overhead where reported. A charge for depreciation was reported by all manufacturers of barium peroxide; by three of the four manufacturers of barium chloride; and by one manufacturer of barium carbonate. No depreciation was reported by manufacturers of blanc fixe. Other discrepancies in cost items are discussed under the variation in costs by companies.

Table 38 shows that the total average cost for precipitated barium carbonate, as reported by three manufacturers, was $0.0316 per pound. This cost was made up of the following items: Material charge of $0.0167, or 52.9 per cent; labor charge of $0.0038, or 12 per cent; and overhead and selling expenses of $0.0111, or 35.1 per cent. This table shows a total average cost for barium peroxide of $0.197 per pound as reported by three companies. Of this total, $0.088, or 44.7 per cent, was due to material charges; $0.046, or 23.3 per cent to labor charge; and $0.063, or 32 per cent, to overhead and selling expenses. The total average cost of blanc fixe for three firms is shown as $0.0294 per pound. This total cost is made up of $0.0160 material charge, or 54.4 per cent; $0.0028 labor charge, or 9.5 per cent; and $0.0106 overhead and selling expenses, or 36.1 per cent. The total average cost of barium chloride for 1919 as reported by four manufacturers was $0.0539 per pound. This total was made up of material charge of $0.0218, or 40.5 per cent; labor charge of $0.0109, or 20.2 per cent; and overhead and selling expenses of $0.0212, or 39.3 per cent.

The barium chemicals in order of their cheapness of manufacture, as shown in Table 38, are blanc fixe, barium carbonate, barium chloride, and barium peroxide. This order would be expected from a knowledge of the process of manufacture. Blanc fixe and barium carbonate, whose costs vary by only 0.22 cent per pound, are made from comparatively cheap chemicals, are precipitated as insoluble compounds, and require but simple operations, such as filtration and drying before marketing. Barium chloride, although made from a cheap material—calcium chloride—is a soluble compound and requires considerable heat for evaporation of solutions. This

is reflected in a higher overhead charge than for blanc fixe and barium carbonate. Barium peroxide requires a higher degree of manufacture than any of the other barium chemicals. It is made from intermediate barium chemicals—barium carbonate or barium nitrate. Large quantities of heat are required for its manufacture, which is reflected in the largest unit overhead charge. Based on percentage of total cost, however, the overhead for barium peroxide is less than for blanc fixe or barium carbonate.

From a study of Table 38 it is seen that the cost of materials is in inverse ratio to the total cost of production. The percentage of the total cost due to material ranges from 40.5 per cent in the case of barium chloride to 54.4 per cent in the case of blanc fixe. It is also seen that the cost due to labor is in direct ratio to the total cost of the various barium chemicals. The percentage of the total cost due to labor ranges from 9.5 per cent for blanc fixe to 23.3 per cent for barium peroxide. The percentage of the total cost due to overhead and selling expense is more nearly uniform than the other cost charges. This charge ranges from 32 per cent of the total cost for barium peroxide to 39.3 per cent of the total cost for barium chloride.

VARIATIONS IN COSTS OF BARIUM CHEMICALS, BY COMPANIES.

TABLE 39.—*Percentage variation in costs of barium chemicals, by companies, for 1919.*

	Total cost.	Material.	Labor.	Overhead and selling expense.
Barium carbonate:				
Company No. 1	101	170	66	58
Company No. 2	100	100	100	100
Company No. 3	69	108	30	52
Barium peroxide:				
Company No. 1	135	246	49	61
Company No. 2	100	100	100	100
Company No. 3	92	63	174	78
Blanc fixe (precipitated barium sulphate):				
Company No. 1	181	178	178	185
Company No. 2	96	139	91	37
Company No. 3	100	100	100	100
Barium chloride:				
Company No. 1	100	100	100	100
Company No. 2	86	136	54	61
Company No. 3	151	255	73	104
Company No. 4	164	91	189	212

Table 39 shows by percentage the variation in the total cost and in the items of cost of each barium chemical by manufacturers. Because of the few manufacturers of each chemical it was impossible to show the variation in costs by publishing the actual units. In each case the firm with the median total cost has been taken as the unit of 100. The other costs are calculated as a percentage of this unit. As can be seen from Table 39 it is generally true that a manufacturer

who has the lowest total cost is not always low in all departments of cost.

This table shows a variation in the total cost of barium carbonate from 69 to 101, or a difference of nearly 50 per cent of the low cost. This difference may be due to differences in process of manufacture, methods of treating by-products, or to individual plant and process efficiencies. There are two general methods used in the manufacture of barium carbonate. The one is to treat barium sulphide with soda ash, thus obtaining by-product sodium sulphide. The other method is to convert the barium sulphide into barium carbonate by means of carbon dioxide. This method does not give a by-product. The accounting method used in treating sodium sulphide may vary between manufacturers with a resulting reflection in the total cost. Sodium sulphide was uniformly treated as a joint product, and the raw-material charges divided between barium carbonate and sodium sulphide on an arbitrary basis. The basis of distribution of raw material, however, varied between the manufacturers. The method followed by each firm has been used in arriving at the total cost.

The total cost of barium peroxide ranged from a low of 92 to a high of 135, or a difference of nearly 50 per cent of the low cost. The variation in the cost of barium peroxide may be accounted for largely by the difference in process of manufacture. It is produced by two methods, one using barium carbonate as the raw material and the other using barium nitrate. The difference in total cost is reflected chiefly in the material charge which shows a difference between the low and high of about 300 per cent. The company with the highest total cost had the lowest labor, while the firm with the lowest total cost had the highest labor cost.

The total cost of blanc fixe varied from 96 to 181, as shown in Table 39. This is a difference of nearly 100 per cent of the low cost. In arriving at the total cost for blanc fixe in the case of one firm it was necessary for comparison to substitute an average material charge, which was the weighted average of the material charges reported by the other two manufacturers. From a study of the variation of costs of blanc fixe, it is seen that the company with the highest total cost is the highest in all departments of cost. This is the only case where one company is the highest in all cost items. What has been said of the effect of sodium sulphide on the cost of barium carbonate, also applies to costs of blanc fixe. Some of the companies reporting blanc fixe costs obtain sodium sulphide as a by-product, while others produce blanc fixe by a process which does not yield sodium sulphide. These differences are necessarily reflected in total costs.

The total cost of barium chloride reported by four companies ranged from a low of 86 to a high of 164, or a difference of about 90 per cent of the low cost. Three of the firms use similar processes involving the direct production of barium chloride from barytes by reduction with coal in the presence of calcium chloride. The other firm reporting made barium chloride from an intermediate barium chemical. The difference in total cost, however, can not be accounted for wholly by differences in process of manufacture. It is interesting to note that the firm with the highest total cost had the lowest material cost, but had high labor and overhead and selling charges.

Cost of Manufacturing Lithopone, 1919.

INTRODUCTORY.

The Commission's investigation of costs in the lithopone industry was greatly facilitated by the fact that practically all companies kept detailed cost records. The methods of accounting used by the lithopone manufacturers were more detailed and in a more comparable form than those of the barytes and barium chemical industries. This may be accounted for by the fact that the lithopone industry is much larger, has been longer established, and is on a more permanent basis than the other industries. Although costs were shown in detail, there was considerable lack of uniformity in methods of treating individual cost items. The outstanding differences were methods of handling raw material charges, methods of determining selling expenses, and treatment of administrative expenses. These differences are discussed fully in the following pages.

In analyzing the cost statements on lithopone for 1919, and in comparing and presenting the cost data of the industry, the methods used by the majority of the companies in distributing the charges have been followed as closely as possible. Wherever changes have been necessary in order to facilitate comparison, they are explained in the discussion of the individual cost items. Where companies operate more than one plant and have reported separate costs for each, they have been tabulated as if for separate companies. The costs for lithopone as shown represent 11 plants, operated by 9 companies. Two plants did not report costs for the first quarter of the year 1919, and one plant presented costs for the last quarter only. The costs of these plants have been used as representative of the entire year.

COMPARISON OF COSTS OF LITHOPONE BY QUARTERS.

TABLE 40.—*Weighted average cost of lithopone during 1919 by quarters.*

[Per pound.]

1	2	3	4	5	6	7	8	9
Quarterly periods.	Production.	Total cost.	Material cost.	Direct labor cost.	Factory overhead.	Selling expense.	Average sales price.	Apparent average profit.
	Pounds.							
First	24,613,042	$0.0639	$0.0264	$0.0101	$0.0239	$0.0035	$0.0709	$0.0070
Second	28,479,697	.0573	.0254	.0103	.0191	.0025	.0633	.0060
Third	41,222,083	.0574	.0254	.0112	.0182	.0026	.0640	.0066
Fourth	48,204,354	.0623	.0264	.0111	.0213	.0035	.0664	.0041
Year	142,519,176	.0602	.0259	.0108	.0204	.0031	.0667	.0065

Table 40 shows the weighted average cost of lithopone for all plants by quarters during 1919. The total average cost for all companies reporting, as shown, is the sum of the items—material, direct labor, factory overhead, and selling expense. This table also shows in column 9 the average profit for the industry by comparing the average gross selling price with the total weighted average cost.

Column 2 shows the production of lithopone by the companies reporting costs during 1919, by quarters. These figures of production were used in obtaining the weighted average costs for each quarter and for the entire year 1919. The figures, however, do not necessarily represent total production of lithopone, because of the omission of certain companies who did not report costs for the whole year. These figures show inactivity in the lithopone industry during the first half of 1919. The production as shown during the first six months was only 53,000,000 pounds, as against 89,500,000 during the last six months of 1919.

Column 3 shows that the total weighted average cost of lithopone for all companies during 1919 was $0.0602 per pound. This average cost was made up of $0.0259 per pound, or 43 per cent for material; $0.0108 per pound, or 17.9 per cent for direct labor; $0.0204 per pound, or 33.9 per cent for overhead; and $0.0031 per pound, or 5.2 per cent for sales expense. The distribution of the total cost of lithopone according to items of expense for the year 1919 is shown diagrammatically in Figure 6. Column 3 also shows that the highest cost for lithopone was $0.0639 per pound during the first quarter of the year. The cost during the second and third quarters was uniform at $0.0573 per pound and increased in the fourth quarter to $0.0623 per pound.

The material cost, as shown in column 4, is the actual unit cost of raw materials used in the manufacture of lithopone, as shown by the books of the various companies. The items making up material cost, as recorded by the various manufacturers, differed greatly. Some companies reported the basic raw materials—barytes, coal for reduction of barytes, zinc, and sulphuric acid. Other companies reported the intermediate materials—barium sulphide and zinc sulphate—which are made from the basic raw materials given above. The relation between the basic raw materials and the intermediate materials, barium sulphide and zinc sulphate, is shown in the diagram of the manufacture of lithopone, Figure 4, page 55. In other words, by this latter method the companies carry separate cost accounts for the intermediate products, barium sulphide and zinc sulphate, and then charge these products at the actual cost of manufacture against their lithopone account as raw materials. Where this latter method has

been followed we have attempted to segregate the cost of zinc sulphate and barium sulphide into labor, raw material, and overhead. This estimated segregation has been done by determining the percentages of labor, raw material, and overhead by a study of the sepa-

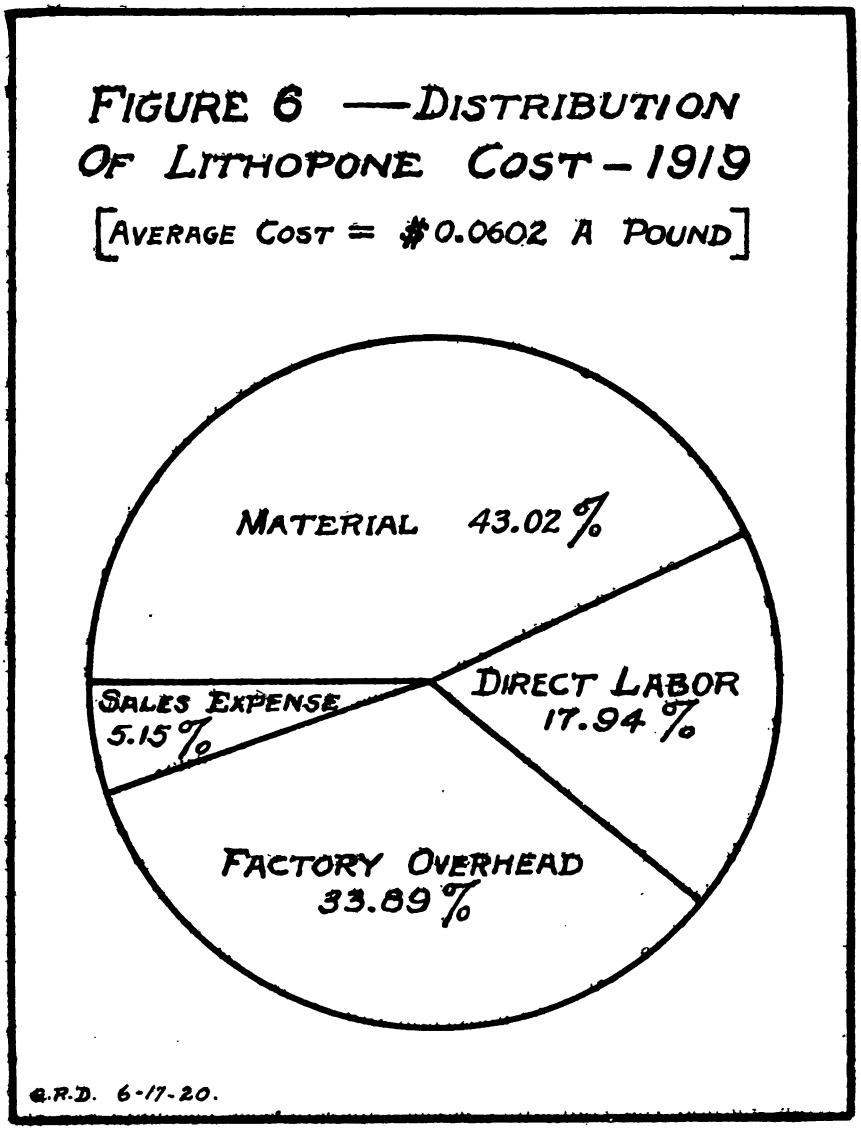
FIGURE 6 —DISTRIBUTION OF LITHOPONE COST – 1919
[AVERAGE COST = $0.0602 A POUND]
MATERIAL 43.02 %
DIRECT LABOR 17.94 %
SALES EXPENSE 5.15 %
FACTORY OVERHEAD 33.89 %
G.R.D. 6-17-20.

rate cost sheets for zinc sulphate and barium sulphide and then applying these percentages in distributing the charges for the zinc sulphate and barium sulphide, as reported under lithopone cost, to raw material, labor, and overhead. The amounts due to labor and over-

been deducted from the lithopone material charge and labor and overhead reported under lithopone cost. This distribution may result in slight discrepancies between cost items, but in no case has the total material charge, d by any company, been changed unless an offsetting change made in some other department of cost, so that the total ıy company has not been changed because of this arbitrary f allocation. Column 4 shows that the average material ll companies during the year 1919 was $0.0259 per pound ne, or 43 per cent of the total average cost. This column s that the material costs followed the general trend of the during the year, although there was only a difference of er pound between the material cost by quarters. The high- ial charge was $0.0264 during the first and fourth quarters, material charge for the second and third quarters was uni- $0.0254 per pound.

irect labor cost, as shown by column 5, is derived from the eported by the companies plus any labor charge resulting e arbitrary allocation due to differences in reporting raw s, as discussed above under column 4. Column 5 shows that age direct labor charge for all companies during 1919 was per pound, or 17.9 per cent of the total cost. The direct labor was fairly uniform during the year, and ranged from $0.0101 rst quarter to $0.0112 in the third quarter.

factory overhead cost shown in column 6 is made up of the eral charges—works expense, bags and barrels, fixed charges, ory expense, and administrative expense. These units have rived from the report as submitted by the respective manufac- with the exception of those companies which reported interest tal invested in inventory, building, machinery, and equipment, arge against lithopone costs. Where these items were given, ave been excluded in arriving at the total average cost of pro- n. This has been necessary for purposes of comparison, be- these charges were not reported by all companies, and in cases where reported they were not actual book charges. have also been a few minor changes in overhead expense, as ed by companies, which was necessary because of the arbitrary tion of material charges, as previously explained under column his table. Column 6 shows that the average factory overhead l companies during 1919 was $0.0204 per pound of lithopone, 9 per cent of the total average cost. This charge ranged during ar from $0.0182 in the third quarter to $0.0239 during the first er.

Column 7 shows the total selling expense charged by the various manufacturers to their lithopone account. Selling expense as reported showed considerable variation in regard to both the method of determination and the relative amounts which were charged. Several of the firms manufacturing lithopone have large sales organizations which also handle other products. Some of these companies distribute the expense of the whole sales organization to the various products according to the value of the sales of the individual products. Those companies making only lithopone usually charged the actual cost of sales. Two other methods were found to be used in determining sales expense. One is to charge a certain percentage of the selling price as sales expense; one firm using this method combines sales and administrative expense. The other is to charge a fixed sum per unit of lithopone produced as sales expense. In all cases, however, the amounts as reported by individual companies have been included in the total average cost of lithopone. Column 7 shows that the average selling expense during 1919 was $0.0031 per pound of lithopone, or 5.2 per cent of the total cost. The selling cost ranged from $0.0025 in the second quarter to $0.0035 in the first and fourth quarters.

In determining the average price received by all companies, as shown in column 8, the gross price received by each company has been used. This unit has been multiplied by the total production of each company and the aggregate for all companies divided by the total production of all companies. By this method the weighted average gross sales price has been obtained. In the case of the few companies not reporting gross sales price, these companies have been omitted in arriving at the weighted average for each quarter and the year. Column 8 shows that the average gross sales price during 1919 was $0.0667 per pound of lithopone. In column 9 is shown the apparent average gross profit, obtained by subtracting the average total cost (column 3) from the average gross sales price (column 8). This estimated average profit during 1919 was $0.0065 per pound of lithopone. The profit shown during the year varied considerably—from $0.0041 in the fourth quarter to $0.0070 per pound in the first quarter.

ITHOPONE, BY COMPANIES.

lithopone during 1919, by companies.

ıd.]

4	5	6	7	8
t	Factory overhead.	Selling expense.	Average sales price.	Average profit or loss (—).
	$0.0203	$0.0020	$0.0649	$0.0120
	.0151	.0022	.0631	.0095
	.0218	.0011	.0646	.0072
	.0166	.0036	.0649	.0063
	.0228	.0066	.0660	.0061
	0208	.0054	.0687	.0052
	0201	.0919	.0627	—.0016
	121	.0014	.0696	.0043
	24	.0011	.....	.....
	76	.0070	.0714	.0030
	4	.0063	.....	.....
		.0031	.....	.....

one by companies
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loss of each firm
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cost between the various manufacturers may be accounted for largely by design and equipment of plant. Although not all lithopone plants were visited by representatives of the Commission, those visited, which appeared to be well designed and utilized labor-saving devices wherever possible, uniformly show a low labor cost per pound of lithopone. There appears to be opportunity for plants with a high labor cost to lower their total cost of lithopone by a greater use of labor-saving devices and better design of plant.

Column 5 shows that the factory overhead per pound of lithopone ranged from a low cost of $0.0121 to a high cost of $0.0324. This is a difference of $0.0203 per pound, or about 165 per cent of the low cost. Five plants show a factory overhead charge lower than the average of $0.0204 per pound.

Column 6 shows the selling expense per pound of lithopone as reported by the different manufacturers. This charge ranged from $0.0011 to $0.0066 per pound of lithopone or a variation of 500 per cent of the low cost. This variation in selling expense is greater than for any other item of cost shown. Six plants show a selling expense lower than the average of $0.0031.

Column 7 shows the average net sales price received by each plant, with two exceptions. The average net price received for all sales during 1919 ranged from $0.0631 per pound to $0.$714 per pound, a variation of $0.0083 per pound. The sales price as shown in column 7 is not a quoted price on lithopone, but is the actual average net price received by each firm for sales during 1919; freight, discounts, and commissions have been deducted.

Column 8 shows the average profit or loss by companies represented by subtracting the total cost (column 2) from the average sales price obtained (column 7). As previously stated, interest on capital investment was not included in arriving at the total cost, and therefore this factor has had no influence on the average profit or loss shown in column 8. This column shows that one plant lost $0.0016 per pound of lithopone, while the other plants made a profit ranging from $0.0030 to $0.0120 per pound.

DETAILS OF MATERIAL COSTS.

tails of material cost compared by percentages with total factory cost of lithopone during 1919, by companies.

[Costs are per pound. Per cent is of total factory cost.]

2	3	4	5	6	7	8	9	10	11	12
Total factory cost.	Total material.		Barytes.		Zinc.		Sulphuric acid.		All other materials.	
	Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.
$0.0509	$0.0248	48.72	$0.0086	16.89	$0.0127	24.96	$0.0025	4.91	$0.0010	1.96
.0514	.0258	50.20	.0091	17.70	.0112	21.79	.0027	5.26	.0028	5.45
.0563	.0221	39.26	.0067	11.90	.0100	17.76	.0030	5.33	.0024	4.27
.0550	.0230	41.82	.0078	14.18	.0122	22.18	.0023	4.18	.0007	1.28
.0543	.0232	42.72	.0053	9.76	.0122	22.47	.0028	5.15	.0029	5.34
.0581	.0283	48.71	.0085	14.63	.0128	22.03	.0027	4.65	.0043	7.40
.0624	.0288	46.15	.0068	10.89	.0141	22.60	.0040	6.41	.0039	6.25
.0639	.0307	48.04	.0083	12.99	.0149	23.32	.0034	5.32	.0041	6.41
.0686	.0251	36.59	.0072	10.49	.0139	20.26	.0018	2.62	.0022	3.22
.0674	.0303	44.96	.0075	11.13	.0153	22.70	.0041	6.09	.0034	5.04
.0688	.0329	47.82	.0096	13.95	.0153	22.24	.0034	4.94	.0046	6.69
V-ALL										
ter, ... .0604	.0264	43.71	.0082	13.57	.0125	20.70	.0032	5.30	.0025	4.14
rter, ... .0548	.0254	46.35	.0077	14.05	.0122	22.26	.0026	4.75	.0029	5.29
rter, ... .0548	.0254	46.35	.0081	14.78	.0124	22.63	.0026	4.75	.0023	4.19
rter, ... .0588	.0264	44.90	.0076	12.93	.0127	21.60	.0030	5.10	.0031	5.27
..... .0571	.0259	45.37	.0079	13.84	.0124	21.72	.0029	5.08	.0027	4.73

le 42 shows by companies the detail of material cost compared otal factory cost. This table also shows the weighted average ial charge for all companies during each quarter and for the year of 1919. The total factory cost as shown in column 2 not include sales expense and is the sum of material, direct , and factory overhead charges. The average factory cost for mpanies during the entire year was $0.0571 per pound of litho- produced. This is a weighted average of individual factory ranging from $0.0509 to $0.0688 per pound.

olumn 3 shows that the total average material cost for the entire was $0.0259 per pound, or 45.37 per cent of the total factory as shown by column 4. The cost of barytes, column 5, for all panies during 1919 averaged $0.0079 per pound of lithopone, or 4 per cent of the total factory cost, column 6. The percentage of factory cost of lithopone due to crude barytes is important in con- lering a duty on crude barytes and its effects on the cost of hopone. The average cost of the crude barytes as reported by of the 11 plants was $13.60 per short ton. With this information e effect of an increase or decrease in the cost of crude barytes on e cost of lithopone can be calculated. For example, a 10 per cent crease or decrease in the cost of barytes given above ($13.60) will

cause an increase or decrease of 1.384 per cent of the total factory cost of lithopone.

An average of 8 of the 11 plants for which costs were reported shows that 1.2 pounds of barytes were required for the production of 1 pound of lithopone during 1919.

Column 7 shows that the average cost of zinc materials for all companies was $0.0124 per pound of lithopone, or 21.72 per cent of the total factory cost as shown in column 8. Zinc is seen to be the most expensive material entering into the cost of lithopone. Column 9 shows that the average cost of sulphuric acid per pound of lithopone for the year was $0.0029, or 5.08 per cent of the total factory cost as shown in column 10. Column 11 shows all other materials entering into the manufacture of lithopone. Under this heading is included coal used in reduction of barytes and various minor chemicals used principally in the purification of zinc liquor before it is used to make lithopone. The average cost of all other materials for 1919 was $0.0027 per pound of lithopone, or 4.73 per cent of the factory cost as shown in column 12.

It should be pointed out that the variation by companies of a given material cost per pound of lithopone and the percentage of factory cost do not necessarily follow each other. One firm may show a low unit cost for a given material, but the percentage of factory cost due to that material may be higher than the percentage shown by another firm with a higher unit cost.

DETAILS OF FACTORY OVERHEAD CHARGES.

TABLE 43.—*Details of factory overhead compared by percentages with total factory cost of lithopone during 1919, by companies.*

[Costs are per pound. Per cent is of total factory cost.]

1	2	3	4	5	6	7	8	9
Plant No.	Total factory cost.	Total factory overhead.		Details of factory overhead.				
		Cost.	Per cent.	Works expense.	Bags and barrels.	Fixed charges.	Laboratory.	Administration.
1	$0.0509	$0.0203	39.89	$0.0147	(1)	$0.0015	(1)	$0.0041
2	.0514	.0151	29.38	.0062	$0.0016	.0031	$0.0001	.0041
3	.0563	.0218	38.72	.0147	.0019	.0029	.0002	.0021
4	.0550	.0166	30.18	.0099	.0013	.0034	.0003	.0017
5	.0543	.0228	41.99	.0155	.0023	.0089	.....	.0011
6	.0581	.0208	35.80	.0163	.0021	.0004	.0006	.0014
7	.0624	.0201	32.21	.0141	.0018	.0034	.....	.0008
8	.0639	.0121	18.93	.0097	.0024	(1)	(1)	(1)
9	.0686	.0324	47.23	.0302	.0016	.0005	.0001	.....
10	.0674	.0276	40.95	.0214	.0025	.0009	.0007	.0021
11	.0688	.0274	39.83	.0221	.0026	.0009	.0006	.0012
WEIGHTED AVERAGE OF ALL COMPANIES.								
First quarter, 1919	.0604	.0239	39.57	.0168	.0016	.0025	.0002	.0028
Second quarter, 1919	.0548	.0191	34.85	.0126	.0012	.0025	.0002	.0026
Third quarter, 1919	.0548	.0182	33.22	.0124	.0016	.0018	.0002	.0022
Fourth quarter, 1919	.0588	.0213	36.22	.0153	.0020	.0018	.0003	.0019
Year	.0571	.0204	35.73	.0142	.0016	.0021	.0002	.0023

[1] Not shown separately but is included in works expense.

Table 43 shows the details of factory overhead compared with total factory cost of lithopone during 1919 by individual plants. This table also shows average factory overhead charges for all companies during each quarter and for the entire year of 1919. The total factory cost and factory overhead per pound of lithopone by companies have been discussed in the preceding pages.

Column 4 shows that the average factory overhead of all plants during 1919 was 35.73 per cent of the total factory cost. It should be pointed out at this point that since some of the plants do not show factory overhead in the same detail as shown in this table by columns 5 to 9, the total factory overhead is the only fair basis of comparison between plants. Although in many cases the units under detail of factory overhead can not be used for direct comparison, the table shows the variation in the detail to which the various plants distribute their overhead expense.

Column 5 showing works expense includes such items as indirect labor, fuel, power, light, and general factory expense. The average works expense for all companies was $0.0142 per pound of lithopone. The costs given under bags and barrels, column 6, is for packages of any kind. Only one plant did not report a separate charge for this item, but included it in works expense. This item is small and fairly uniform for all companies. The average cost for packages during the year was $0.0016 per pound of lithopone.

Fixed charges, column 7, include items of expense such as insurance, depreciation, and State and local taxes. In all cases but one the charge reported is an actual expense and not an estimated one. One firm included fixed charges in works expense. The average of all plants reporting such charge for 1919 was $0.0021 per pound of lithopone. Column 8 shows the expense due to maintenance of a chemical laboratory. This charge was shown separately by seven plants. In all cases the charge for laboratory was small.

Administration charges as shown in column 9 represents salaries paid to executives and general office expense. The charges vary greatly with the size of the organization, but as the charge is relatively small it has little effect on the total cost of lithopone. The methods used by various companies in arriving at administrative expenses are practically the same as the methods used in determining sales expense, namely, actual expense, percentage of sales price, or a fixed sum per unit of product.

DETAILS OF SPECIAL CHARGES.

TABLE 44.—*Details of special charges per pound of lithopone, by companies, during 1919.*

[Per pound.]

1	2	3	4	5
Company No.	Total of special charges.[1]	Depreciation.	Interest on borrowed money.	Imputed interest.[2]
1	$0.0015	$0.0015	.....	.....
2	.0016	.0016	.....	.....
3	.0027	.0027	.....	$0.0021
4	.0026	.0020	$0.0006	.....
5	.0040	.0033	.0007	.0021
6	.0003	.0003	.....	.....
7	.0032	.0022	.0010	.....
8	.....	.....	.....	.....
9	.0005	.0005	.....	.....
10	.0009	.0009	.....	.....
11	.0009	.0009	.....	.....
Weighted average	.0018	.0017	.....	.....

[1] Total special charges included in total factory overhead.
[2] Imputed interest not included in costs of lithopone production.

Table 44 shows the detail of special charges per pound of lithopone during 1919 by companies. The total special charges in column 2 were included in total factory overhead. The total average special charges were $0.0018 per pound of lithopone and ranged by companies from no charge to a charge of $0.0040 per pound.

Imputed interest or interest on capital invested in inventories, buildings, and equipment, as shown in column 5, was not included in the total cost of lithopone. It is given here to show that it was considered a cost by two plants.

Depreciation shown in column 3 is on buildings and equipment. Generally the depreciation is a certain percentage of the investment in buildings and equipment and ranges from 1 to 15 per cent. In one case the depreciation is figured as a percentage of the appraised value. In another instance depreciation was not included as a current cost, but was charged to profit and loss at the end of each fiscal year. In some cases a uniform rate of depreciation was applied to both building and equipment, while in other cases a different rate was applied to buildings than to equipment. As shown in column 3, depreciation is the chief special charge and averaged $0.0017 per pound of lithopone for 1919. Column 4 shows that interest on borrowed money was charged against lithopone costs by three plants. This has been included in the total cost.

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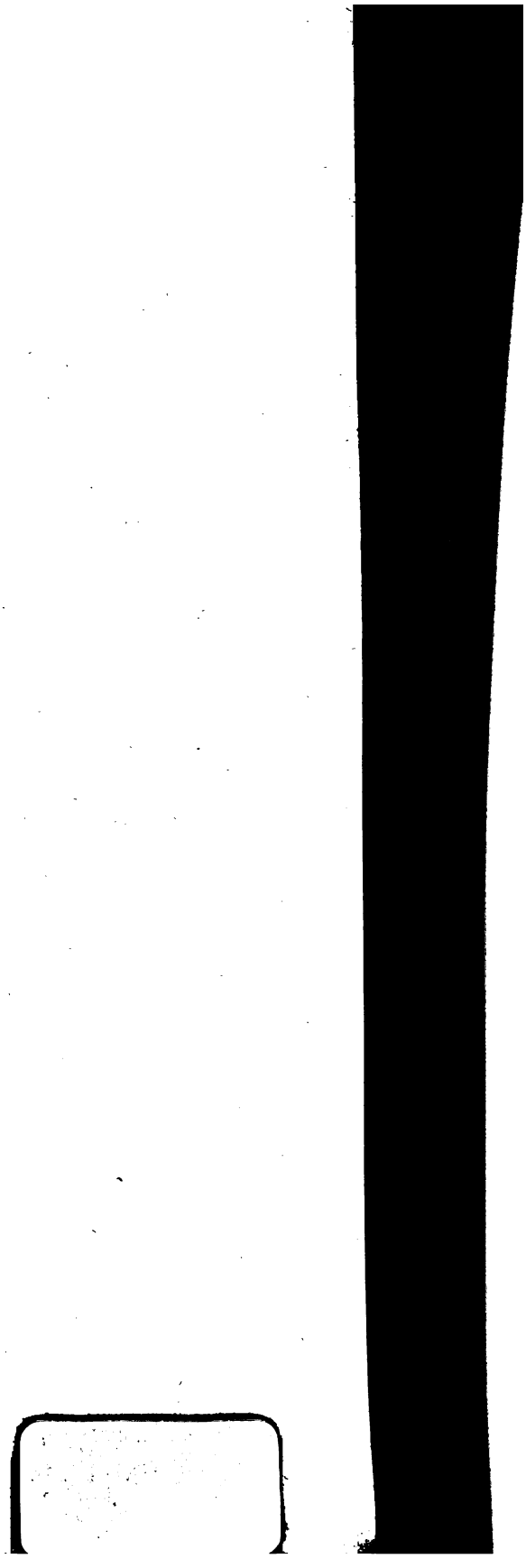

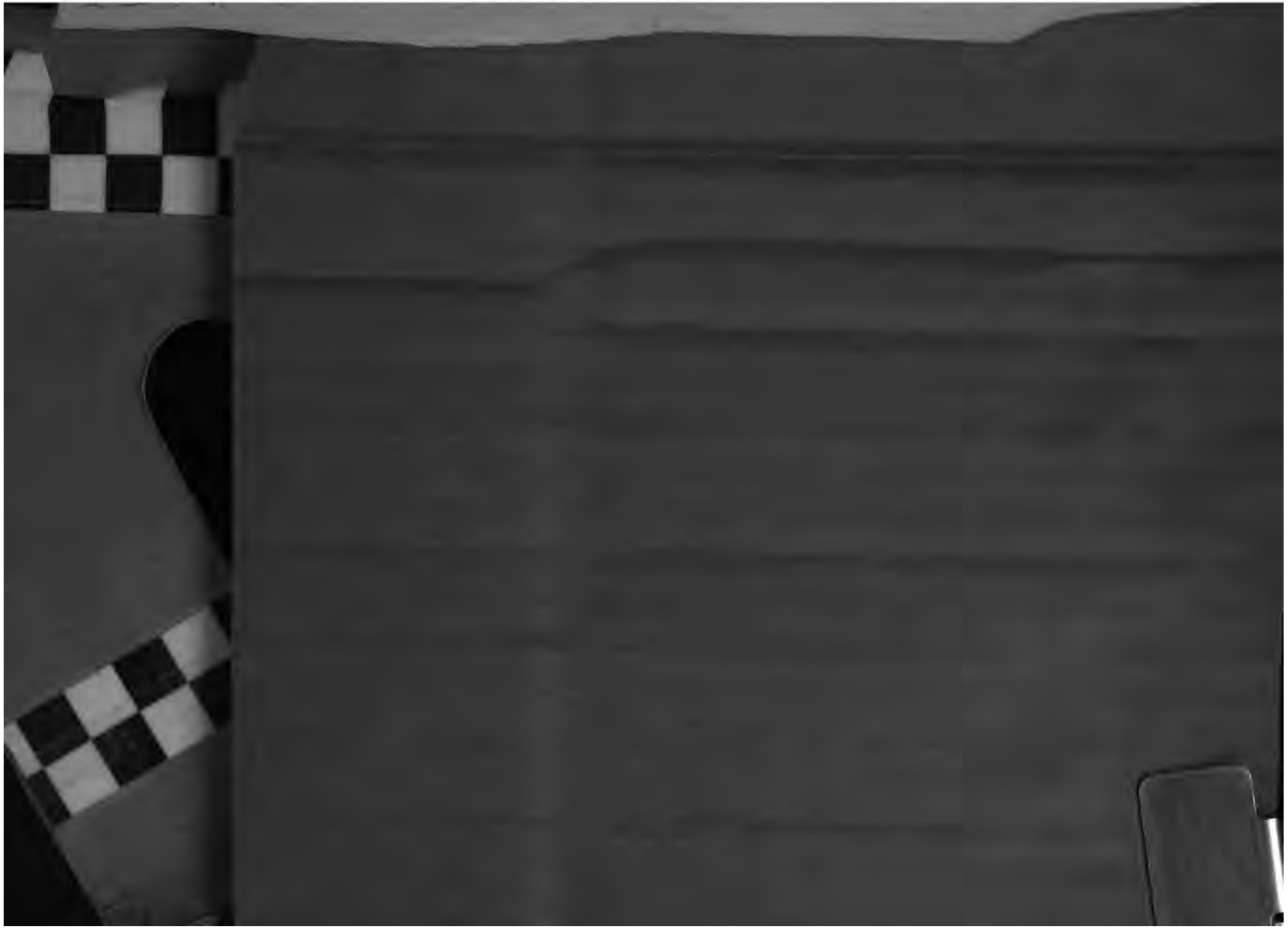

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 2 AND 3 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

THE WOOD CHEMICAL INDUSTRY

Paragraph 2:
Acetic anhydride.

Paragraph 3:
Acetone.
Acetone oil.

Paragraph 32:
Formaldehyde.

Paragraph 387:
Acetic or pyroligneous acid.

Paragraph 393:
Alcohol, wood or methyl.

Paragraph 440:
Calcium acetate.

Paragraph 447:
Charcoal.

Paragraph 626:
Tar and pitch of wood.

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U.S. Tariff Com.
6-4-28

PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an Introduction and Index, which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus by use of this Introduction and Index, the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of C. R. DeLong, of the chemical division of the Commissions staff and of others.

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ACETIC ANHYDRIDE.

[Paragraph 2, act of 1913, 2½ cents per pound.]

General Information.

Description and uses.—Acetic anhydride, acetyl oxide, acetic oxide, or so-called "anhydrous acetic acid," is a chemical compound derived from acetic acid by the removal of water. It has the chemical formula $(CH_3CO)_2O$. Acetic anhydride is a colorless liquid which has a strong acetic odor. It has a specific gravity of 1.08 and boils at about 138° C. The vapors of acetic anhydride have an irritating effect on the eyes which causes a copious flow of tears. Acetic anhydride is corrosive in its action on the skin and should be handled with care.

A good grade of acetic anhydride should be water-white, should contain no chlorides, should not destroy the color of permanganate, and should leave a nonweighable residue on evaporation. The commercial grade contains about 90 per cent of acetic anhydride, the remaining percentage being chiefly acetic acid.

Acetic anhydride combines with water to form acetic acid. This combination proceeds very slowly in the cold but is greatly hastened by warming. The vapors of acetic anhydride have a very destructive action on most of the metals.

It is used chiefly in the manufacture of acetyl salicylic acid (aspirin) and cellulose acetate. It also has minor uses in organic analysis and synthesis.

Raw materials.—Acetic anhydride on an industrial scale is manufactured from an alkali acetate, usually sodium acetate, as the basic raw material. Phosphorous chloride or sulphur chloride are also used in the process of manufacture. (See report on sulphur chloride.) It is usually produced in conjunction with other chlorine products or by manufacturers of pharmaceutical chemicals such as acetyl salicylic acid (aspirin).

Process of manufacture.—Acetic anhydride on a commercial scale is made by the action of sulphur chloride on fused sodium acetate. The sodium acetate as usually purchased on the market contains water of crystallization. The sodium acetate is, therefore, thoroughly dried, usually by fusing. The fused sodium acetate is then ground to a powder and subjected to the action of the phosphorous chloride or sulphur chloride in an iron retort. The sodium acetate is converted into acetic anhydride which is then distilled out of the retort, usually under a vacuum. The crude acetic anhydride is then redistilled, usually in a glass-enameled still, the distillate coming over between the temperatures of 130° and 140° being taken as acetic anhydride.

Phosphorous chloride is used in the above process instead of the sulphur chloride when a very pure product is desired. However, phosphorous chloride is a more expensive reagent than the sulphur chloride. There are many patents on the manufacture of acetic anhydrid, but the above is the general method of manufacture in the United States.

Acetic anhydrid is produced at Midland, Mich.; Charleston, W. Va.; Carteret, N. J.; and St. Louis, Mo. At St. Louis it is manufactured as the raw material for pharmaceutical chemicals while at the other plants it is manufactured as one of several chlorine products.

History of the industry.—Prior to the war the acetic anhydrid used in this country was imported from Germany. It was then used for the manufacture of cellulose acetate for photographic purposes. The imports amounted to something over 1,000,000 pounds annually. During the fiscal year 1912 the imports of acetic anhydrid dropped to one-fifth the amount imported prior to that year. The Journal of Industrial and Engineering Chemistry, 1912, page 311, contains the following comment on the situation:

> This sharp decline in the consumption of acetic anhydrid is probably due to abandonment of the manufacture of cellulose acetate for photographic purposes.

Since the outbreak of the European war the imports of acetic anhydrid have been practically negligible. At the same time there has been a new demand created for acetic anhydrid, namely, for the manufacture of aeroplane "dopes." Acetic anhydrid enters into the manufacture of aeroplane dopes in the manufacture of cellulose acetate, which is then dissolved in a suitable solvent, such as amylacetate, to form a varnish or "dope" for protecting aeroplane wings. This has resulted in the establishment of plants for the manufacture of acetic anhydrid in this country. In addition with the expiration of the patents on the manufacture of "aspirin" other firms have entered the production of this article, which requires acetic anhydrid as one of the raw materials. This has caused a corresponding increase in the demand for acetic anhydrid.

Owing to these increased demands for acetic anhydrid and the fact that manufacturers in this country were inexperienced in its manufacture, acetic anhydrid has been quoted at a price of $1.90 to $2 per pound. Since January, 1918, the price has declined, slightly due to the increased production and the effect of the Government fixing the price at 85 cents per pound for a product containing 85 per cent acetic anhydrid.

Acetic anhydrid—imports for consumption—revenue.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	2½ cents per pound	1,295,308	$248,103	$32,382	$0.192	13.05
1911	do	1,170,485	218,676	29,262	.187	13.38
1912	do	254,977	44,069	6,374	.173	14.46
1913	do	309,643	51,632	7,741	.167	14.99
1914	do	150,892	23,240	3,772	.154	16.23
1915	do	3,652	1,019	91	.279	8.96
1916	do	18,177	10,013	454	.551	4.54
1917	do	9,060	7,485	226	.826	3.03
1918	do	13,112	16,433	328	1.253	1.99
1919	do	10,948	14,780	274	1.350	1.85
Calendar year:						
1918	do	19,662	27,601	491	1.403	1.78
1919	do	[1]				
1920 [2]	do	[3]				

[1] Not listed. [2] Jan. 1 to July 1, 1920. [3] Listed, but no imports.

Prices of acetic anhydride,[1] wholesale spot, New York market.

[Metallurgical and Chemical Engineering.]

Month.	1916	1917	1918	1919	1920
January			$1.80-$1.90	$1.60-$1.85	$0.60-$0.65
February			1.35- 1.50	.90- 1.00	.60- .65
March			1.35- 1.50	.90- 1.00	.60- .65
April			1.35- 1.50	.65- .70	.60- .65
May			1.35- 1.50	.55- .60	.65- .75
June			1.50- 1.60	.52- .60	.65- .75
July			1.50- 1.60	.52- .60	.65- .75
August			1.60- 1.85	.54- .60	.65- .75
September		$1.90-$2.00	1.60- 1.85	.55- .60	.65- .75
October		1.90- 2.00	1.60- 1.85	.55- .60	.65- .75
November		1.90- 2.00	1.60- 1.85	.60- .65	.65- .75
December		1.90- 2.00	1.60- 1.85	.60- .65	.65- .75

[1] On Dec. 24, 1917, price of acetic anhydride (85 per cent) was fixed by the Government at 85 cents per ound, which was effective until Jan. 1, 1919.

Acetic anhydride—Rates of duty.

Act of—		Tariff classification or description.	Rates of duty, specific and ad valorem.
Year.	Par.		
1883	12	Acid, acetic, * * * exceeding the specific gravity of 1.047 [1]	10 cents per pound.
1890	1	Acetic * * * acid, * * * exceeding the specific gravity of 1.047.	4 cents per pound.
1894	1	Acetic * * * acid	20 per cent ad valorem.
1897	1	Acids: Acetic * * * acid, * * * exceeding the specific gravity of 1.047.	2 cents per pound.
1909	1	* * * : acetic anhydride	2½ cents per pound.
1913	2	Acetic anhydride	2½ cents per pound.

[1] Acetic anhydride has a specific gravity in excess of 1.047 (see p. 7).

Court and Treasury Decisions.

Acetic acid anhydride, while not chemically an acid, was held to come within the provision for acetic acid in the act of 1897. (Lueders *v.* United States, T. D. 26460, reversing G. A. 5051 (T. D. 23426); followed in G. A. 6101 (T. D. 26590); T. D. 26548).

THE PRIMARY PRODUCTS OF THE HARDWOOD DISTILLATION INDUSTRY.

Introductory.

The wood distillation industry is divided into two distinct branches, according to whether the wood used is hard wood or soft wood: (1) The hardwood distillation industry, and (2) the wood turpentine industry, which uses chiefly pine wood. The relative size of the two wood distillation industries is shown by the fact that out of a total of 94 wood distillation plants in 1914, there were 79 plants distilling hardwood and only 15 plants engaged in the distillation of pine woods. The hardwood distillation industry during this year consumed 970,308 cords of wood, as against 72,209 cords of pine woods consumed by the wood turpentine industry.

The primary products of the distillation of hard woods are calcium acetate, wood alcohol, charcoal, and tar, while the products of the

distillation of pine wood are turpentine, pine oils, pine tar, and pitch. So far as known there is only one firm distilling pine wood which recovers the wood alcohol and acetic acid produced. The distillation of pine wood is more closely allied to the naval stores or gum turpentine industry, and is therefore not included in this report. The primary products of the hardwood distillation industry discussed in this report are provided for in the tariff act of October 3, 1913, as follows:

Paragraph 393: "Alcohol, methyl or wood." (Free list.)
Paragraph 440: "Calcium, acetate of, brown and gray, * * *." (Free list.)
Paragraph 447: "Charcoal, * * *; not suitable for use as a pigment." (Free list.)
Paragraph 626: "Tar and pitch of wood." (Free list.)

DESCRIPTION AND USES.

Calcium acetate, or acetate of lime, is a gray granular chemical substance obtained by neutralizing acetic acid with lime. There were formerly two commercial grades of acetate of lime, known as "brown" and "gray." The brown grade was made by adding lime to the crude pyroligneous liquor obtained from the distillation of wood. This liquor contained more or less tar, which contaminated the acetate of lime and thus gave a brown product. This grade has had no market for several years past. Gray acetate of lime is the ordinary commercial product, and is made by neutralizing the acetic-acid solution obtained by distilling the crude pyroligneous liquor. This grade usually contained 80 to 82 per cent of calcium acetate, 4 to 7 per cent of water, and the remainder consists of various impurities. The 80 to 82 per cent of calcium acetate includes a certain small percentage of calcium salts or other organic acids, such as butyric and proprionic.

Practically all of the acetate of lime is used as the raw material for the manufacture of acetic acid and acetone. The manufacture of acetic acid is the most important use in peace times. Pure calcium acetate is used to some extent as a mordant in dyeing textiles.

Wood alcohol, wood spirit, wood naphtha, or in chemical nomencla ture, methyl alochol, is a colorless, highly inflammable liquid. In distinction from ethyl alcohol (grain alcohol) it is poisonous, both when taken internally and when applied externally. The large number of casualties due to drinking liquor containing wood alcohol since the prohibition amendment went into effect has caused manufacturers of wood alcohol to seek a name not containing the word "alcohol." This has resulted in a wide usage of the term "methanol," which will be used throughout this report.

Pure methanol has a specific gravity of 0.79647 (156° C.) and weighs about 6.64 pounds per gallon. It boils between 65 and 66° C. The commercial grades of methanol range from 82 per cent (crude wood alcohol) to chemically pure methanol. The 82 per cent grade is that ordinarily produced at wood distillation plants, and the 82 per cent includes about 16 per cent of acetone. This grade is usually sold to central refineries for further purification, although certain quantities are sold direct to the consumer, and in a few cases it is refined at wood-distillation plants. The common refined grades of methanol are 95 per cent, 97 per cent, and pure. The grades other than the pure contain acetone as the chief impurity. The percentage strength of methanol refers to that determined by the Tralle's hydrom-

eter, which includes in the reading any acetone or methyl acetate present. Therefore, 82 per cent, or better 82° Tralle, crude methanol is a total of the methanol, acetone, and methyl acetate present.

The most important uses of methanol (wood alcohol) are the manufacture of formaldehyde, and in the manufacture of dimethylaniline, an important intermediate for coal-tar dyes. These two uses have caused a large increase in the demand for wood alcohol in recent years. For both of these purposes pure methanol is required. For the manufacture of formaldehyde the methanol must contain less than 0.1 per cent of acetone. Next in importance is the use of methanol as a solvent in the pyroxylin plastics industry (celluloid, films, artificial leather, etc.). It is also used for denaturing ethyl or grain alcohol to be used for industrial purposes. For this purpose it must conform to specifications of the Bureau of Internal Revenue, Treasury Department. Methanol, or wood alcohol, has other minor uses as a solvent and as a chemical reagent.

Charcoal is the charred residue which is left after the volatile products contained in the wood have been driven off during the distillation. It was formerly used almost exclusively in the manufacture of high-grade iron, but for this purpose it has been replaced to some extent by coke, which is a strong competitor of charcoal for this purpose. About 50 per cent of the charcoal is used for this purpose. An additional 25 per cent is used for metallurgical and chemical operations, including the manufacture of ferrosilicon, refining of copper, and manufacture of sodium cyanide. The remainder is used in the household as a fuel, for which purpose it is sold in small paper sacks. A special grade of charcoal is required in the manufacture of "sporting powders."

Tar and pitch.—The tar produced in the distillation of hardwoods is usually burned for fuel under the carbonizing ovens, as the production is far in excess of the market demand. A certain portion is refined for the production of pitch and wood creosote. Beechwood creosote, especially, is used in the curing of meats, principally artificially smoked ham, and as the raw material for the preparation of creosole and creosole carbonate.

Domestic Production.

Materials.—The primary requirement of a wood distillation plant is a large and closely available supply of the raw material, wood. This fact results in the location of the wood distillation plants at the source of supply. The wood used by the hardwood distillation industry is chiefly beech, birch, and hard maple. The eastern field uses principally beech, while the western field used mostly hard maple. The wood is cut and split in suitable sizes and then is allowed to season or dry by being stored from 6 to 18 months.

This seasoning is necessary to reduce the moisture content of the wood, because if wood with a high moisture content is used the time of distillation is prolonged, the yield of products is decreased, and more fuel is required. In recent years artificial drying of the wood has been introduced in a few of the large wood distillation plants.[1]

[1] Hawley, L. F.: "Recent Developments in the Hardwood Distillation Industry and Suggestions for the Future," Chem. and Met. Eng., Sept. 8, 1920, p. 466.

The cordwood, or after being cut into small blocks (about 5 inches long), is dried in preheaters by means of waste heat from the ovens in which the wood is later carbonized. By this method the wood can be dried in three days. This results in economy in the cost of piling the wood and a decrease in the time a large amount of capital is tied up in large stocks of wood when natural drying is used.

The Commerce Department [1] reported that the cost of wood used by wood distillation plants in 1916 averaged slightly over $4 per cord. The cost of wood delivered at wood distillation plants has increased greatly since 1916. At the present time (November, 1920) the price of cordwood delivered at wood distillation plants will vary between $7 and $10 per cord. It may be estimated that the average price will be approximately $8.50 per cord delivered at the plant.

Process of manufacture.—To obtain the wood distillation products the seasoned or dried wood is heated gradually to about 380 to 400° C. in a closed chamber. This process is known as dry or destructive distillation. The types of apparatus in common use are known as ovens or oven retorts and kilns. The oven is gradually supplanting all other types, as it permits of increased economy in fuel and operation and gives a higher yield of products. The vapors given off during the heating of the wood are condensed as they escape from the chamber. The residue left from the dry distillation of the wood is the well-known charcoal of commerce. After all the gases are driven off the charcoal is withdrawn from the carbonizing chamber and, to prevent spontaneous combustion, allowed to cool in so-called charcoal coolers before being placed in cars for shipment. Each charge of wood remains in the ovens about 24 hours.

During the distillation there is first evolved considerable carbon dioxide and air, but from about the middle of the run until the end the uncondensed gases have an important fuel value, as they then consist chiefly of carbon monoxide and hydrocarbons which form a highly combustible gas mixture.

The crude distillate (pyroligneous acid) resulting from the condensation of the vapors is pumped to a series of settling tubs, where the major part of the tar is removed. The raw liquor, now free from the most of the tar, is run into continuous copper stills, where the lighter volatile products (methanol, acetone, and acetic acid) are separated from the tars and oils, which are dissolved in the solution. This neutralized liquor is then distilled in a continuous column, still known as the "lime lee" still. The distillate from this still is a dilute methanol and acetone mixture of approximately 15° Tralles.

The liquor discharged from the "lime lee" still is a dilute solution of acetate of lime. This solution is evaporated in vacuum evaporators to a certain strength and then is transferred to open steam pans, located above the ovens, where it is further evaporated to a mushy consistency. It is then shoveled out onto the "kiln floor," which is a sheet-iron surface directly over the ovens, to dry. In this manner the radiated heat from the carbonizing ovens is utilized in the final drying of the acetate. This product is the commercial "gray acetate of lime."

[1] Benson, H. K.: "By-Products of the Lumber Industry," Department of Commerce, Special Agents Series No. 110, 1916.

In recent years a continuous method of drying acetate of lime has been introduced. By this method the concentrated acetate liquor is evaporated to a mushy consistency on a revolving heated drum. The partially dry acetate of lime is then scraped from the drum and pressed into meshes of a traveling belt which passes through a heated chamber in which the acetate is thoroughly dried. It is automatically removed from the belt when completely dried.

Soda ash may be used instead of lime in the above process, thus producing acetate of soda. It was formerly the practice in many plants to neutralize the crude pyroligneous acid with lime without purifying it by distillation. This produced "brown acetate of lime," which was formerly an article of commerce.

The dilute alcohol and acetone mixture obtained in the above process from the "lime lee" still containing 10 to 15 per cent alcohol and acetone is distilled in a fractionating still. The distillate from this still is the crude wood alcohol of commerce (82 per cent Tralles) and is usually shipped to a central plant for further refining. This crude wood alcohol is sold on a basis of 82 per cent (Tralles) methyl alcohol, which includes about 16 per cent of acetone. This crude product is worked up by fractional distillation into the various refined grades of methanol (wood alcohol) and methyl acetone. The acetone present which was formerly objectionable distills over first with some methanol and this distillate is the commercial methyl acetone or acetone-alcohol, which contains approximately 50 per cent methanol, 25 per cent acetone, and 25 per cent methyl acetate. Thus, this 16 to 18 per cent of impurity which was formerly objectionable now gives an added source of income to the refiner.

The tar which has been settled from the crude pyroligneous liquor is usually burned for fuel along with the combustible gases. These, together, supply a large part of the fuel for carbonizing the wood, in some cases as much as 75 per cent. A certain portion of tar, however, is refined, producing wood oils, pitch, and wood creosote. There is an increasing demand for wood oils in the flotation process of ore concentration.

Yields of products.—The yield of products obtained varies greatly according to kind of wood used, degree of drying, type of apparatus used, and other operating conditions. Yields will necessarily vary when calculated on a cord basis, as a cord of wood may vary in weight from 3,000 to 5,000 pounds. So far as known, only one domestic manufacturer calculates the yield of products on a unit weight of dried wood carbonized.

The yield per cord of seasoned wood of acetate of lime ranges from 180 to 210 pounds, crude wood alcohol (82 per cent) from 8 to 10 gallons, and charcoal from 45 to 50 bushels. In addition, considerable quantities of tar and combustible gases are obtained, which are used for fuel in carbonizing the wood.

According to official Canadian statistics[1] during 1918 in Canada the average production per cord of wood was approximately 8.18 gallons of crude wood alcohol, 200 pounds of acetate of lime, and 53 bushels of charcoal.

Size of industry.—Data submitted to the commission by the forest products laboratory, Department of Agriculture, shows that in the latter part of 1917 the capacity of hardwood distillation plants in

[1] "Wood Distillation, 1917," Dominion Bureau of Statistics, Ottawa, Canada.

the United States was about 4,556 cords daily. It is estimated, however, that during 1917 the actual production was only about 75 to 80 per cent of the rated capacity. Plants built during the war by the United States Government have increased the capacity to between 5,000 and 5,500 cords per day. The rated capacity of most wood distillation plants is usually too high. It may be estimated that the present productive capacity of the industry is close to 5,000 cords per day. The following is a list of plants erected by the Government during the war:

Mississippi Wood Products Co., Charleston, Miss.
Mid-Continent Iron Co., Midco, Mo.
Shelby Chemical Co., Shelby, Ala.
Tennessee Valley Iron & Railroad Co., Collingwood, Tenn.
Kingsport Wood Reduction Co., Kingsport, Tenn.
Sutton Chemical Co., Sutton, W. Va.
Bon Air Iron Co., Lyle, Tenn.

Michigan and Pennsylvania produce over 70 per cent of the primary wood distillation products, with Michigan slightly ahead of Pennsylvania. New York and Wisconsin rank next as producing States. Although Michigan and Pennsylvania produce over 70 per cent of both the crude wood alcohol and acetate of lime, New York is the leading producer of refined wood alcohol. This is due to the location of a large central refinery at Buffalo, N. Y.

Production of primary products of the distillation of wood, by States.

[From Census of Manufactures, 1914, Department of Commerce.]

States or cities and product.	1909		1914	
	Quantity.	Value.	Quantity.	Value.
Wood alcohol, refined.....gallons..	6,276,071	$2,901,709	6,235,113	$2,709,369
Michigan	1,661,589	684,743	1,570,658	588,908
New York	4,129,345	2,058,844	4,229,389	1,956,397
All others	485,137	158,122	435,066	164,064
Wood alcohol, crude.....gallons..	6,359,848	1,627,878	7,196,975	1,605,880
Michigan			1,593,134	364,507
New York	2,370,713	676,443	939,523	227,626
Pennsylvania	3,376,374	797,010	4,235,636	904,700
All other	612,761	154,425	428,682	109,047
Acetate of lime.....pounds..	132,141,442	1,981,220	163,521,577	2,138,909
Michigan	32,907,258	467,476	57,756,234	718,753
New York	24,511,279	372,045	19,452,927	264,482
Pennsylvania	69,488,589	1,069,884	77,140,287	1,043,636
All others	5,234,316	71,815	9,172,129	112,038
Charcoal.....bushels..	39,017,247	2,351,644	44,827,836	2,829,571
Michigan	13,514,106	868,003	19,152,454	960,414
New York	5,147,160	287,103	4,004,412	302,299
Pennsylvania	16,357,598	936,357	17,726,774	1,318,109
All other	3,998,383	260,181	3,944,196	248,749

Capitalization and organization.—The Census of Manufactures, 1914, shows the number of establishments distilling wood to be 95 (includes 15 distilling pine wood). There have been several additional plants erected during the war, and it is estimated that at the present time there are about 100 wood-distillation plants in the United States, representing an investment of about $50,000,000.

The fact that a wood-distillation plant must have a large and easily obtainable supply of wood keeps the industry divided into a large number of plants located at the source of the raw material. In the past these wood-distillation plants, as a rule, have not cared to manufacture beyond the crude products (acetate of lime, crude wood alcohol, and charcoal). The working up of crude wood alcohol into the refined grades and of the acetate of lime into acetic acid and acetone has been carried on by other manufacturers; in some cases by large consumers. This is clearly shown by the fact that in 1914 out of a total of 79 plants producing crude wood alcohol only 9 plants refined their own product. There were 7 plants engaged solely in refining the crude wood alcohol produced by other wood-distillation plants. This is also shown by the fact that in 1914 over 80 per cent of the crude wood alcohol was produced in Pennsylvania and Michigan, while about 65 per cent of the total refined wood alcohol was credited to the State of New York. This situation is readily accounted for by the location of a large central refinery at Buffalo, N. Y., operated by the Wood Products Co. Acetate of lime has been sold by the manufacturers chiefly to a single firm of jobbers and exporters. There has been a tendency in recent years, however, for the wood-distillation plants to combine the manufacture of the crude products with that of the refined or finished products (acetic acid, refined wood alcohol, and acetone).

Production and consumption.—The United States possesses by far a larger and more firmly established wood-distillation industry than any other country. It is stated that the European and Canadian production of wood-distillation products is about equal to the total output of this country. This indicates that the United States supplies at least 50 per cent of the world's demand for wood-distillation products. The production prior to the war was in excess of domestic demands, as shown by the fact that in 1914 about 41 per cent of the calcium acetate and 17 per cent of the wood alcohol produced in this country was exported.

The total output of all products of the destructive distillation of wood (includes pine wood) shows only a slight increase, from $10,312,829 in 1909 to $10,529,829 in 1914. There was, however, during the war a great stimulus to the production of wood chemicals, and plants were erected by the Government. The War Industries Board has estimated the production of acetate of lime in 1917 to be 200,000,000 pounds. This is a 22 per cent increase over the production in 1914. This same increase would apply also to the production of the other products, wood alcohol and charcoal.

The following table gives statistics of the wood-distillation industry (includes distillation of pine wood) for 1909 and 1914:

Statistics of the wood distillation industry, 1909 and 1914.

[From Census of Manufactures, 1914, Department of Commerce.]

	1909	1914
Number of establishments	136	101
Wood distillation industry	120	95
Subsidiary wood products	16	6
Number producing wood alcohol	98	79
Number producing refined alcohol	17	16
Number distilling pine wood	33	15

Statistics of the wood distillation industry, 1909 and 1914.

		1909	1914
MATERIALS.			
Wood	cords	1,265,157	1,042,517
Hardwoods		1,149,847	970,308
Pine		115,310	72,209
Crude wood alcohol:			
Consumed	gallons	9,670,497	8,070,902
Purchased	do	7,135,614	5,665,446
Value		$1,784,029	$1,408,124
Made and consumed	gallons	2,534,883	2,405,456
PRODUCTS.			
Total value		$10,312,657	$10,529,829
Wood distillation industry		$9,736,998	$9,882,537
Subsidiary products, others		>575,659	$647,292
Wood alcohol:			
Crude	gallons	9,307,583	9,602,431
For sale	do	6,772,700	7,196,975
Value		$1,774,459	$1,605,880
Made, consumed	gallons	2,534,883	2,405,456
Refined	do	.....	6,464,955
For sale	do	6,732,877	6,235,113
Value		$3,096,808	$2,709,369
Made, consumed	gallons	(1)	229,842
Acetate of lime	pounds	.....	166,084,523
For sale	do	141,478,296	163,521,577
Value		$2,118,443	$2,138,909
Made, consumed	pounds	(1)	2,562,946
Turpentine	gallons	706,868	575,557
Value		$249,526	$194,183
Tar	gallons	.....	2,965,354
For sale	do	1,570,257	1,476,797
Value		$113,225	$145,984
Made, consumed	gallons	(1)	1,488,557
Wood creosote	pounds	2,549,190	2,073,057
Value		$34,645	$38,872
Charcoal	bushels	39,952,235	44,827,836
Value		$2,426,648	$2,829,571
Rosin	barrels	(1)	51,825
Value		.....	$198,165
Other wood distillation products[2]		$231,192	$441,399
All other products		$267,711	$227,497

[1] Figures not available.
[2] Includes acetic acid, acetate of soda, acetone, formaldehyde, pyrolignite of iron, and wood ashes.

Exports of domestic products.—The United States is the leading exporter of wood distillation products, especially acetate of lime. The exports of acetate of lime had reached a maximun prior to the war of 80,579,838 pounds, valued at $2,221,427 in 1913. The exports of Austria-Hungary, the leading European producer, was about 1,000,000 pounds during the same year. The domestic exports in 1914 amounted to 41 per cent of the total domestic output. Exports of acetate of lime decreased rapidly during the war, because of the large demand for acetone, as a solvent in the manufacture of explosives and aeroplane varnishes. They reached a low level of 12,959,220 pounds, valued at $607,847 in 1917. During the 1918 and 1919 calendar years the export of acetate of lime was about 16,000,000 pounds annually. During 1920 the exports, based on figures for eight months, will be about 30,000,000 pounds, or about 40 per cent of the prewar exports. The exports prior to the war were chiefly to Belgium, Germany, Netherlands, Italy, and Japan. In 1918 (calendar year) France took over 80 per cent of the total export, and in 1919 more than 80 per cent went to Japan.

The exports of wood alcohol prior to 1915 were between 1,500,000 and 2,000,000 gallons. In 1914 the export was 1,598,776 gallons, valued at $652,486. The exports during the war showed an appreci-

able decrease from this quantity only in 1915 and 1917. In 1918 the exports increased greatly to 2,538,001 gallons, valued at $2,070,026, with 80 per cent of the total going to France. Prior to the war Germany was the principal consumer. The exports during the calendar years 1919 and 1920 were less than 800,000 gallons annually.

The exports of charcoal, which are chiefly to Canada, have been rather variable and reached a maximum of $155,470 in 1917. Since then the exports of charcoal have not been separately shown.

The following tables show the exports of wood distillation products by countries:

Exports of calcium acetate from the United States, by countries.

Exported to—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Europe:						
Belgium	25,852,683	$414,769	27,118,462	$611,210	22,915,749	$513,080
Denmark			258,103	6,050	615,139	14,250
France	695,437	10,410	1,339,538	28,900	327,036	7,150
Germany	18,872,215	309,047	14,967,155	335,675	16,727,836	385,700
Italy	3,856,099	62,993	1,995,924	45,350	4,288,176	99,820
Netherlands	11,677,737	202,983	10,539,988	231,271	15,326,676	347,700
Spain	681,981	10,755	789,634	17,650	1,006,238	22,900
Sweden	248,134	5,050	291,673	7,150	202,643	5,065
United Kingdom	1,710,642	28,238	1,924,791	39,731	2,939,210	56,648
Asia: Japan	2,243,109	41,497	3,681,779	86,181	5,834,583	154,469
All other	714,026	10,659	780,382	14,169	7,970	197
Total	66,552,063	1,096,401	63,687,429	1,423,337	70,191,256	1,606,979

Exported to—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Europe:						
Belgium	28,100,568	$638,500	27,120,455	$753,709	18,182,949	$422,718
Denmark	254,490	5,700	58,792	1,700	54,750	1,750
France	234,240	5,200			1,454,488	22,215
Germany	16,797,421	384,450	24,705,968	666,405	18,476,573	419,405
Italy	4,906,956	112,050	4,042,224	118,100	4,852,331	110,070
Netherlands	11,576,946	260,759	13,712,527	355,637	16,490,778	348,760
Spain	852,510	20,900	1,195,920	37,700	1,163,350	23,830
Sweden	186,130	4,400	153,148	4,950	196,066	3,450
United Kingdom	596,973	14,804	568,425	15,531	1,039,443	17,482
Asia: Japan	5,370,752	135,931	7,598,709	226,643	5,710,942	174,674
All other	358,429	10,091	1,423,670	41,052	538,554	16,579
Total	69,235,415	1,592,785	80,579,838	2,221,427	68,160,224	1,560,933

Exported to—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	739,931	$10,990				
Denmark			755,451	$55,083		
France	479,137	9,126	773,910	46,181	2,605,730	$102,516
Germany	1,284,822	19,110				
Italy	5,153,655	102,063	3,677,769	196,060	7,226,650	333,659
Netherlands	7,409,363	144,865	4,252,593	199,487	1,231,799	62,780
Spain	1,889,647	38,243	969,524	49,931	116,521	4,080
United Kingdom	1,460,119	22,873	4,275,695	261,175	1,533,377	94,703
Argentina	447,498	10,265	62,480	1,562	115,071	4,500
Japan	5,391,578	120,271	3,688,873	136,867		
All other	417,497	8,599	348,677	15,299	130,074	5,609
Total	24,673,247	486,405	18,804,972	961,645	12,959,222	607,847

Exports of calcium acetate from the United States, by countries—Continued.

Exported to—	1918	
	Pounds.	Value.
France	9,437,193	$499,079
Italy	3,538,238	153,277
Japan	1,426,980	93,842
All other	1,087,621	51,798
Total	15,490,032	797,996

	1918 (calendar).		1919 (calendar).	
	Pounds.	Value.	Pounds.	Value.
France	13,813,689	$651,894	.....	.....
Italy	783,233	33,065	523,446	$10,468
Japan	973,671	65,303	13,625,461	347,720
United Kingdom	55,620	4,080	1,696,227	35,995
Total	15,682,813	758,622	16,362,929	410,646

Exports of wood alcohol.

Exported to—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Europe:						
Belgium	119,355	$39,615	85,589	$43,000	59,514	$36,650
France	18,575	5,150	22,745	8,600	21,595	9,322
Germany	568,214	161,534	654,517	258,588	974,707	410,316
Italy	2,850	1,425	.....	.....	8,295	5,025
Netherlands	.....	.....	173,314	70,800	471,678	196,900
United Kingdom	376,943	168,388	333,641	169,005	376,633	193,507
North America:						
Canada	209	105	4,539	2,370	2,486	1,078
Panama	8,025	4,253	1,075	590	8,315	3,685
Asia: Japan	2,350	1,277	49,829	26,930	36,490	24,213
All other	3,974	2,041	3,352	1,937	2,623	1,295
Total	1,100,495	383,788	1,328,601	581,820	1,962,336	881,991

Exported to—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Europe:						
Belgium	93,402	$36,010	55,620	$34,950	43,040	$24,394
France	25,996	11,065	3,940	1,800	.....	.....
Germany	815,216	337,450	1,227,872	498,112	939,580	359,122
Italy	34,132	20,000	.....	.....	.....	.....
Netherlands	102,617	43,400	180,595	77,754	176,271	71,946
United Kingdom	403,583	186,551	265,647	125,233	348,574	156,904
North America:						
Canada	30,799	14,896	80,660	39,916	77,191	33,072
Panama	4,283	2,143	8,638	3,780	4,036	1,568
Asia: Japan	50,302	31,270	9,702	3,983	1,808	1,205
All other	5,038	2,780	4,499	2,615	8,276	4,275
Total	1,565,368	685,565	1,837,173	788,143	1,598,776	652,486

Exports of wood alcohol—Continued.

Exported to—	1915		1916		1917	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
Europe:						
Belgium	500	$320				
France	155,861	67,025	466,337	$266,031	266,221	$216,042
Germany	101,252	34,540				
Italy	5,785	2,425	6,400	4,400		
Netherlands	4,000	2,100	631	425		
United Kingdom	557,589	275,789	797,417	463,074	504,903	397,310
North America:						
Canada	61,105	24,920	72,723	33,547	343	333
Panama	3,423	1,418	10,285	7,448	341	336
Asia: Japan	23,444	13,328	40,931	25,241	26,492	10,597
All other	31,415	16,981	77,534	56,995	25,394	20,822
Total	944,374	438,846	1,472,258	857,161	823,694	645,439

Exported to—	1918		Calendar years.			
			1918		1919	
	Gallons.	Value.	Gallons.	Value.	Pounds.	Value.
Europe: France	1,925,371	$1,393,917	2,036,976	$1,445,400	1,950	$2,785
United Kingdom	508,729	556,879	500,851	499,599	177,525	236,434
North America: Canada	17,216	18,778	982	443	254	304
Asia: Japan			4,010	6,804	28,335	38,062
British Africa	28,682	30,089	13,355	13,525		
All other	57,973	70,363	68,138	70,179	510,363	472,582
Total	2,538,001	2,070,026	2,624,312	2,035,950	718,427	750,167

Exports of charcoal.[1]

Exported to—	1910	1911	1912	1913	1914	1915	1916	1917
Germany	$2,642	$4,650	$3,575	$2,752	$4,625	$705		
United Kingdom	2,065	1,657	1,032	2,869	3,329	2,381	$5,695	$2,636
Canada	16,946	17,586	39,883	64,612	71,298	100,334	83,866	145,003
Total	25,310	27,317	45,726	73,030	81,997	105,009	94,096	155,470

[1] Not listed since 1917.

Foreign Production.

Of the foreign countries which possess wood distillation industries the most important prior to the war was Austria-Hungary. The other foreign countries which have industries of minor importance are Germany, France, Canada, Belgium, Russia, and Sweden. The industries in these countries are by no means as large as the industry in the United States. The foreign plants, as a rule, are smaller than those in this country. Austria-Hungary produces the larger part of the foreign output. The industries in these countries are discussed briefly as follows:

AUSTRIA-HUNGARY.[1]

Although reliable production statistics are not available it is known that Austria-Hungary ranked second to this country prior

[1] The wood distillation plants are located in those parts of the empire which have been established as separate monarchies or republics since the war.

to the war in the production of wood chemicals. Germany, a large consumer of wood chemicals, particularly of methyl alcohol for her dye industry, offers ready markets for Austria-Hungary's output. The export statistics of Austria-Hungary show Germany as her principal consumer. They also reveal that Austria-Hungary preferred to manufacture her acetate of lime into the finished products (acetone and acetic acid) and export these rather than exporting the raw material. Austria-Hungary's exports of calcium acetate decreased from 10,212,810 pounds in 1909 to 1,023,816 pounds in 1913. This decrease, however, was partially compensated by increased exports of acetone. The exports of wood alcohol from Austria-Hungary had reached 14,312,263 pounds (about 2,100,000 gallons) in 1913, which is greater than exports of this country with the exception of those in 1918.

Table following shows the exports of wood chemicals from Austria-Hungary from 1909 to 1913, inclusive.

Austria-Hungary's imports and exports of wood chemicals.[1]

[From Statistik der Auswartigen handels der Oesterreichische-Ungarischen monarchie.]

Year.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
CALCIUM ACETATE.	*Pounds.*		*Pounds.*	
1909	10,212,810	$225,251	220	$5
1910	3,679,257	67,624	.....	.....
1911	5,253,782	96,563	.....	.....
1912	4,973,357	91,409	.....	.....
1913	1,023,816	18,817	.....	.....
METHYL ALCOHOL.				
1909	12,078,562	1,057,348	4,189	366
1910	11,956,207	758,145	4,850	423
1911	10,870,221	649,324	8,377	731
1912	14,026,106	837,838	7,496	654
1913	14,312,263	854,931	6,173	539
ACETONE.				
1909	1,874,130	327,237	3,527	681
1910	3,699,980	255,018	10,362	1,428
1911	2,951,739	230,572	4,189	577
1912	3,664,045	454,574	6,614	1,216
1913	3,290,586	319,021	219,358	30,339
ACETIC ACID, CONCENTRATED.				
1909	3,038,600	129,848	22,046	1,013
1910	2,478,191	105,900	20,723	1,047
1911	2,576,477	109,716	24,692	1,248
1912	3,020,522	129,076	26,235	1,326
1913	3,442,262	145,516	25,573	1,293

[1] Figures for years later than 1913 are not available.

CANADA.

WOOD DISTILLATION INDUSTRY.[1]

Size of industry.—In 1917 the total capacity of wood distillation plants in Canada was about 600 cords per day, or 193,616 cords per year. The actual consumption was 137,466 cords in 1917 and 128,097 cords in 1918, or 71 and 66 per cent, respectively, of the total capacity.

[1] Abstracted from Wood Distillation, 1917, and press notice, "The wood-distillation industry, 1918;" Dominion Bureau of Statistics, Ottawa, Canada.

The cost of wood per cord at works was $6.88 in 1917 and $10.30 in 1918. These prices for cord wood correspond closely with those existing in the United States.

The total amount of capital invested in the industry in 1918 was $3,612,573, of which $2,321,881 was credited to Ontario and $1,290,692 to Quebec.

Thirteen plants, 11 of which are distillation plants, and 2 refineries furnish the entire production and are, with two exceptions, controlled by the Standard Chemical Iron & Lumber Co. of Canada (Ltd.). According to location, there are 4 distillation plants and 1 refinery in the Province of Quebec, and 7 distillation plants and 1 refinery in the Province of Ontario.

It can be seen that the wood-distillation industry of Canada is comparatively small, the total capacity amounting to only about 12 per cent of the capacity of the industry in the United States.

Increased output.—The production of wood chemicals in Canada has increased about 50 per cent from 1915 to 1918, as is shown by the production of acetate of lime. This product increased in output from 17,498,547 pounds in 1915, to 25,998,139 pounds in 1918. The value at works increased from $2.18 per 100 pounds in 1915, to $3.90 in 1918.

The following table shows the production of wood chemicals in Canada for 1915, 1917, and 1918:

Class of products, compared by quantity and value, for 1915, 1917, and 1918.

Classes of products.	1915		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Wood alcohol, crude (sold as such) ..... gallons..	731,329	$323,815	934,874	$980,316	875,024	$981,535
Wood alcohol, refined (sold as such) ..... gallons..	514,903	334,749	615,087	818,065	1,070,928	1,531,356
Acetone alcohol..... do....	290,676	156,965	214,548	285,348	.....	.....
Acetate of lime..... pounds..	17,498,547	379,069	27,440,947	945,232	25,998,139	1,017,465
Acetic acid, crude (sold as such) ..... pounds..	366,498	10,994	1,562,775	90,799	1,772,223	170,173
Acetic acid, refined (sold as such) ..... pounds..	221,083	33,162	168,676	38,458	.....	.....
Acetate of soda..... do....	15,580	1,558	301,406	47,019	295,572	51,389
Acetone..... do....	2,687,469	403,120	3,515,477	780,503	3,458,810	909,570
Formaldehyde..... do....	2,395,989	263,559	1,717,909	281,737	1,154,902	159,263
Ketone oils..... do....	71,256	38,476	1,276,266	196,135	792,864	211,440
Other acids..... do....	.....	.....	49,634	48,492	.....	.....
Methyl acetate..... do....	.....	.....	150,930	45,279	132,121	29,350
Other miscellaneous products. do....	.....	65,000	.....	127	.....	597,975
Charcoal..... bushels..	5,750,822	424,249	7,276,066	703,666	6,472,925	1,575,701
Total value.....	.....	2,434,716	.....	5,261,176	.....	7,235,217

SYNTHETIC ACETIC ACID.

The output of acetic acid in Canada has been greatly increased during the war by the production of acetic acid synthetically from calcium carbide.

This process was developed at Shawinigan Falls, Quebec, by the Canadian Electro Products Co. Calcium carbide, which is produced at Shawinigan Falls in large quantities, is first treated with water to form acetylene gas, which is then chemically combined with water, in the presence of mercury salts as a catalyst, to form acetaldehyde. The acetaldehyde is then oxidized to acetic acid. The acid produced

is of high purity and concentration in contrast to that produced from acetate of lime, which requires several distillations to concentrate and purify it.

The original Canadian plant was erected with the idea of converting the acetic acid into acetone, which was in large demand for the manufacture of the British explosive cordite. The production of acetone by this method proved too expensive and only acetic acid was made.

The original plant, with a capacity of 700 to 800 tons of acetic acid (100 per cent) per month, was destroyed by an explosion in the latter part of 1918. During the war the Canadian firm erected another plant with funds advanced by the United States Government. This plant was practically completed at the signing of the armistice and soon after was put into operation. The disposition of claims of the Canadian firm against the United States Government, amounting to over $1,000,000, has not been announced up to the present time (December, 1920). The Canadian firm, however, controls the patent rights on the process, and the necessary water power at Shawinigan Falls and is alone familiar with the technical details. The productive capacity of the present plant is about 650 tons per month of 100 per cent acetic acid. This is roughly equivalent to about 1.300 tons of acetate of lime, or about 15 per cent of the productive capacity of acetate of lime in the United States.

GERMANY.

Germany, prior to the war, was a large consumer of wood chemicals, and a large part of the exports from the United States were to this country. The prewar consumption of acetate of lime in Germany was, roughly, 77,000,000 pounds, of which about 44,000,000, or 57 per cent, was imported.[1] The prewar production of 33,000,000 pounds of acetate of lime in Germany is about 17 per cent of the productive capacity in the United States. No information is available as to the development of the wood chemical industry in Germany during the war. It is reported that two plants have been established for producing synthetic acetic acid from calcium carbide, but the capacity of these plants is not known at this time. The extent to which Germany has become self-sufficient in wood chemicals will be an important factor in the future export trade of the United States in these products.

SWEDEN.

The wood distillation industry in Sweden is not nearly so large as that of Austria-Hungary or the United States. In 1915 there were 23 charcoal and wood distillation plants in Sweden, with an output valued at $1,088,771. The industry as shown by production statistics is confined largely to the primary products of wood distillation as the production of wood chemicals requiring further manufacture is relatively small. The production of formaldehyde and acetone was started in 1913 and 1914, and has increased since. Sweden was the only important producer of wood distillation products which was not engaged in the war. It is evident from the quantity of turpentine and tar produced in Sweden that a fairly large portion of the wood distilled is resinous.

[1] Ullmann, Dr. Fritz: "Enzyklopadie der technischen Chemie," Vol. V, p. 9.

Table following shows the production of wood distillation products in Sweden.

Production of wood distillation products in Sweden, 1910–1915

Product.	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Wood alcohol	1,090,274	$74,453	1,047,185	$73,357	1,352,844	$96,080
Tar and tar oils	10,370,445	107,197	11,446,248	132,559	13,319,342	151,220
Pitch and pitch oils	159,161	1,774	263,353	3,013	484,243	5,595
Wood oils	15,432	375	104,736	2,253	186,558	2,260
Turpentine oil	1,941,523	51,216	2,438,285	71,841	1,490,290	53,945
Total of those listed	13,576,835	235,015	15,299,807	283,023	16,833,277	309,100
	1913		1914		1915	
Wood alcohol	1,161,277	$83,447	1,192,096	$81,451	1,345,712	$123,606
Tar and tar oils	14,553,629	163,637	13,496,045	170,669	16,018,394	250,915
Pitch and pitch oils	397,844	4,691	396,517	4,628	413,792	7,192
Wood oils	376,484	4,877	443,989	7,959	590,654	16,413
Turpentine oils	1,387,432	50,733	1,421,788	54,924	2,915,983	198,907
Formalin	278,655	24,489	501,377	51,812	705,840	120,204
Acetone			12,125	2,760	84,172	33,184
Acetate of lime	2,013,433	40,281	1,617,237	28,731	2,384,703	59,510
Liquid resins	1,747,836	28,619	1,665,178	27,006	2,188,672	87,036
Creosote and others	144,273	7,726	117,152	9,192	383,733	66,297
Total	22,060,863	408,500	20,863,504	439,132	27,031,655	963,264

[1] Industri, Sveriges Officiella Statistik.

FRANCE.[1]

The wood distillation industry in France is about equal in size to that of Canada. The French industry consumes about 166,000 cords of wood per year. The output of products from this quantity of wood is reported as 110,340,000 pounds of charcoal; 792,000 gallons of wood alcohol (with a value of $463,000), and 36,817,000 pounds of acetate of lime, valued at $805,775. The output of wood distillation products in France is not sufficient to supply the total requirements and considerable quantities are imported.

JAPAN.

Prior to the war Japan did not possess a wood distillation industry, but imported her supply of these products. The prewar exports of acetate of lime from the United States to Japan averaged about 7,000,000 pounds a year. During the war Japan developed a wood distillation industry. During 1917 and 1918 the production of acetate of lime was over 15,000,000 pounds annually, and methanol (wood spirit) was more than 1,000,000 pounds (about 150,000 gallons) yearly. The output of acetate of lime in Japan is only about 8 per cent of the productive capacity in the United States. It is problematical whether the industry in Japan is on a sound economic basis, due to her limited forest reserves. This is further evidenced by the fact that during the 1919 calendar year the United States exported over 13,000,000 pounds of acetate of lime to Japan. This quantity is only slightly less than the production in Japan in 1918. It is likely that Japan in the future will depend largely on imports for a

[1] Duchemin, R. P., L'Industrie Chemique et les Droits de Douanes, Syndicat General des Produits Chimiques, Paris, 1918.

supply of wood chemicals. The following table shows the output of wood chemicals in Japan from 1915 to 1918, inclusive:

Production of wood chemicals in Japan.[1]

Year.	Acetic acid.		Acetone.		Wood spirit.		Acetate of lime.	
	Pounds.	Value.[2]	Pounds.	Value.[2]	Pounds.	Value.[2]	Pounds.[3]	Value.[2]
1915	4,285,216	$614,438	1,308,123	$340,396	234,189	$35,194	4,523,859	$159,837
1916	5,658,171	1,302,602	1,109,146	518,191	561,032	112,791	8,577,351	230,002
1917	6,993,760	2,011,873	728,900	395,122	1,064,410	230,113	15,149,674	834,030
1918	9,656,554	2,026,222	929,891	623,970	1,272,916	336,424	15,146,847	884,857

[1] From Thirty-fifth Statistical Report of the Department of Agriculture and Commerce, Japan.
[2] Converted yen at par ($0.4985).
[3] Converted from kwan as 9.267 pounds.

Imports into the United States.

Imports of acetate of lime are combined in official statistics with other articles so that separate figures are not available. The import for the group, however, is relatively small. Imports of charcoal are also lacking.

The imports of wood alcohol prior to the war reached a maximum of 109,022 gallons, valued at $42,598, which was equal to about 1 per cent of the domestic production during 1914. The imports during the war were much less than in 1914. In 1918 (fiscal year), however, the imports increased to 205,276 gallons, valued at $202,994. During the calendar year 1918 imports were less than 70,000 gallons and 1919 were negligible. During the first six months of 1920 the imports were 565 gallons, valued at $1,951. The following table shows the imports of wood alcohol:

Alcohol, wood or methyl—Imports for consumption.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Average ad valorem rate.
		Gallons.				*Per cent.*
1910	20 per cent	13,412	$5,696	$1,139	$0.42	20
1911	do	366	319	63	.87	20
1912	do	157	185	37	1.18	20
1913	do	362	387	77	1.07	20
1914	do	48	60	12	1.25	20
1914	Free	108,974	42,538		.39	
1915	do	39,485	11,880		.30	
1916	do	46,829	9,496		.20	
1917	do	11,267	4,502		.40	
1918	do	205,276	202,994		.99	
Calendar years:						
1918	do	68,449	106,702		1.56	
1919	do	1	5		5.00	
1920 (6 months)	do	565	1,951		3.45	

Tariff History.

Acetate of lime and wood alcohol have not been mentioned by name in the tariff acts prior to the act of 1913, when they were both specifically made free of duty. Prior to 1913, they were dutiable under basket clauses.

Charcoal has been free of duty under the various tariff acts with the exception of the period covered by the act of 1909 when it was dutiable at 20 per cent ad valorem.

COMPETITIVE CONDITIONS.

The situation prior to the war.—The wood distillation industry is larger and more firmly established in the United States than in any other country. The largest European producing country is Austria-Hungary. Others, producers of lesser importance, are Canada, Germany, France, Russia, and Sweden. Prior to the war there was very little competition offered to the domestic industry in our own markets and the United States supplied a considerable portion of world's demand for wood chemicals. The competitive strength of this country in wood chemicals is shown by the fact that in 1914 about 41 per cent of the acetate of lime and 17 per cent of the wood alcohol produced in this country were exported.

The present situation.—The competitive situation in the wood distillation industry has been somewhat modified as a result of the war. The large demand for acetone for military explosives caused the development and the establishment on a commercial scale of several new processes by which either acetone or acetic acid is the product. Thus, these new processes offer competition on two products, formerly produced only by the wood chemicals industry. It is also interesting to note that these two products are made from one product—acetate of lime—of the wood distillation plants.

The question arises whether these processes can offer serious competition to the American wood distillation industry. They can be divided as follows:

1. Fermentation processes.
2. Synthetic acetic acid by carbide process.
3. Burton process (acetone as by-product of cracking petroleum oils).

1. Acetone, a further manufacture of acetate of lime, was made during the war by the fermentation of molasses, corn, and kelp. The plant erected at Terre Haute, Ind., for producing acetone and butyl alcohol by fermentation of corn was reopened during March, 1920. The successful operation of this process in peace times is due to the development of an outlet for butyl alcohol as a solvent for pyroxylin plastics. This process produces 1 part of acetone for every 2 parts of butyl alcohol. The extent to which acetone from this process will compete with that from wood distillation industry is dependent largely on the use of butyl alcohol. This process is patented and controlled by the Commercial Solvents Corporation, an American firm.

2. The process for producing acetic acid from calcium carbide was developed in Canada and has been established on a commercial basis at Shawinigan Falls, where cheap water power is available for the manufacture of the necessary raw material, calcium carbide. This plant has remained in operation since the signing of the armistice. It is competition from acetic acid produced by this process which the domestic wood distillation industry fears the most.

It should be pointed out, assuming that acetic acid produced by this process will be able to compete with that made from acetate of lime in this country, that the competition will be only on one of the three products of the wood distillation plants, namely, acetate of lime. Should competition from this source cause a decline in the prices at which wood distillation plants could sell their acetate of lime for the manufacture of acetic acid, then, in order to exist, this decrease

must be offset by an increased revenue from the other principal products, wood alcohol and charcoal. As charcoal must compete with coke for its principal use this decrease must be made up on chiefly the wood alcohol. If the wood distillation plants can secure a combined revenue on acetate of lime and wood alcohol which is greater than the cost of production so as to enable them to operate at a profit, this competition from synthetic acetic acid will not be harmful to the industry. On the other hand, should the industry not be able to secure a combined revenue on these two products which would net them a profit, this competition would then be harmful.

The maximum competition from synthetic acetic acid (based on productive capacity of Canadian plants) would be equivalent to about 15 per cent of the productive capacity of acetate of lime in the United States.

3. The process of producing acetone from propylene, a waste gas from the cracking of petroleum oils offers possible domestic competition to acetone made from acetate of lime. Although this process has not been introduced on a commercial scale, it gives considerable promise of success. The acetone is obtained by a fairly simple chemical process from a cheap by-product raw material. It should be able to compete with acetone made from acetate of lime.

In considering competitive conditions in the wood chemical industry during 1919 and 1920 the fact should not be overlooked that to a large degree the depression has been due to a demoralization of the export market for acetate of lime and wood alcohol. Prior to the war this country exported annually about 75,000,000 pounds of acetate of lime while in 1920 the exports will not exceed 30,000,000 pounds. Prewar exports of wood alcohol amounted to about 1,800,000 gallons yearly, while in 1919 and 1920 less than 800,000 gallons were exported each year. The inability of the wood chemical industry to export acetate of lime and wood alcohol during the past two years in quantities comparable with prewar exports has seriously depressed the industry.

ACETIC OR PYROLIGNEOUS ACID.

Description and Uses.

Paragraph 387, act of 1913: "Acids: Acetic or pyroligneous * * *." (Free List.)

Acetic acid, when pure, is a clear, colorless liquid having a sharp characteristic odor. It is the constituent which gives vinegar its sour taste. The strong acid is very irritating to the skin. Pure acetic acid solidifies at about 15° C. and it is this property which gives it the name "glacial acetic acid." This grade usually contains over 99 per cent of acetic acid. Other common commercial grades contain 28, 56, and 80 per cent of acetic acid.

The specific gravity of acetic acid increases on dilution with water until a maximum density is reached in a solution containing 77 per cent of acetic acid, on further dilution the density decreases. The specific gravity therefore, at certain densities, is not a true indication of the strength of the acetic acid unleess accompanied by the statement "below or above 77 per cent." It is more reliable to determine the strength of acetic acid by actual chemical analysis.

The largest use for acetic acid is in the manufacture of the pigments white lead and verdigris. A dilute grade of acetic acid is ordinarily used for this purpose. Acetic acid is also used in the printing and dyeing of textiles; in the leather industry; in the preparation of numerous acetates, such as aluminum, chromium, and ammonium, which are used in the dyeing tissues and rendering them impervious. Acetic acid directly or through sodium acetate enters into the manufacture of many important drugs, such as acetanilid, acetyl salicylic acid (aspirin) and acetphenetidin (phenacetin), acetic anyhdride; cellulose acetate; and acetic esters, such as amyl acetate and ethyl acetate. Considerable quantities of acetic acid are used in the manufacture of insecticides, especially lead arsenate; for laundry purposes; and in the manufacture of inks. Glacial acetic acid is treated with chlorine to form monochloracetic acid, which has an important use in the manufacture of indigo. Acetic acid is used as a chemical reagent and has many minor chemical uses.

Pyroligneous acid is the crude acetic acid—wood-alcohol solution obtained as the watery distillate in the destructive distillation of wood. It usually contains on an average 10 per cent of acetic acid; 1 per cent of wood alcohol, and about 0.1 per cent of acetone. There are also present other alcohols, phenols, and tarry substances. It is a dark-brown liquid having a strong acid reaction and peculiar empyreumatic color. This crude product is not generally an article of commerce, as it would not be economical to ship such a dilute solution of acetic acid. It is usually purified by distillation and then treated with lime or soda-ash to separate the acetic acid as acetate of lime or acetate of soda from the wood alcohol and acetone. It, however, has a limited use in the manufacture of an impure acetate of iron, known as pyrolignite of iron, which is used in the dyeing of textiles. It is seen that the term "pyroligneous acid" is not synonymous with "acetic acid." The word "or" in paragraph 387 should be changed to "and."

Domestic Production.

Acetic acid is not produced directly from crude pyroligneous acid obtained in the distillation of wood as might be expected, but is obtained through the intermediate product, acetate of lime or acetate of soda by treatment with sulphuric or hydrochloric acid. Acetate of lime is the principal intermediate material used. A process has been developed during the war for the production of acetone, which produces acetic acid as an intermediate product.

Acetic acid from acetate of lime or soda.—Acetate of lime is distilled with concentrated hydrochloric acid in a copper still, care being taken to have an excess of acetate present. The acid produced by this method is colored and contains about 50 per cent of actual acetic acid. This product is usually purified by redistilling and gives the commercial "56 per cent, redistilled, acetic acid." If the hydrochloric acid is diluted somewhat before the distillation a much purer acid is obtained which is the "28 per cent acetic acid" of commerce.

Glacial acetic acid can be prepared by distilling pure anhydrous acetate of soda with concentrated sulphuric acid. A nearly anhydrous glacial acetic acid is obtained, which crystallizes on cooling to 16.5° C. Glacial acetic acid can also be made by treating acetate of lime with sulphuric acid. This produces the 80 per cent acetic acid of commerce. This is subjected to fractional distillation to obtain glacial acetic acid.

This process using calcium acetate has the objection that an insoluble residue of sulphate of lime is left in the still and is difficult to remove.

A large part of the necessary equipment for the manufacture of acetic acid must be made of copper and is therefore expensive. Since the acetic acid industry has been established in this country for over 60 years, the manufacture of necessary equipment has become well established in this country and the American producers are in no way at a disadvantage in procuring equipment.

Acetic acid from calcium carbide.—Large war demands for acetone as a solvent for explosives led to the commercial development of a process for making acetic acid from calcium carbide. It was intended to convert the acetic acid produced by this process into acetone, but this proved too expensive and only acetic acid was produced.

This process was developed at Shawinigan Falls, Quebec, by the Canadian Electro Products Co. Calcium carbide, which is produced at Shawinigan Falls in large quantities, is first treated with water to form acetylene gas, which is then chemically combined with water in the presence of mercury salts as acatalyst to form acetaldehyde. The acetaldehyde is then oxidized to acetic acid. The acid produced is of high purity and concentration in contrast to that produced from acetate of lime, which requires several distillations to concentrate and purify it.

The original plant, with a capacity of 700 to 800 tons of acetic acid (100 per cent) per month, was destroyed by an explosion in the latter part of 1918. During the war the Canadian firm erected another plant with funds advanced by the United States Government. This plant was practically completed at the signing of the armistice, and soon after was put into operation. The disposition of claims of the Canadian firm against the United States Government, amounting to over $1,000,000, has not been announced up to the present time (December, 1920). The Canadian firm, however, controls the patent rights on the process and the necessary water power at Shawinigans Falls and is alone familiar with the technical details.

The productive capacity of the present plant is about 650 tons per month of 100 per cent acetic acid.

Acetic acid by fermentation.—In the production of acetone by fermentation of molasses acetic acid is produced as an intermediate product and then converted into acetone. The United States Industrial Chemical Co., at Curtis Bay, Md., produced about 35 tons of acetic acid (100 per cent) from molasses residues during the war. The molasses is first fermented to alcohol, which is recovered and converted into acetic acid by another fermentation, which involves percolation over wood shavings carrying the proper bacteria.

Organization.—In recent years many of the manufacturers of acetate of lime have taken up the production of acetic acid instead of selling the acetate of lime to other manufacturers to work up into acetic acid and acetone. Some of the larger consumers, such as paint manufacturers, purchase acetate of lime and produce their own acetic acid for the manufacture of pigments. The question of whether it is more economical to produce acetic acid at the source of acetate of lime (wood distillation plants) or at the point of consumption must be decided by local conditions.

Production and consumption.—The production of acetic acid increased in quantity from 58,000,602 pounds in 1909 to 75,303,375 in

1914, while the value decreased from $1,336,874 in 1909 to $1,272,294 in 1914. The value is probably a truer indication of the industry, owing to the various strengths of acetic acid that are produced. The number of establishments producing acetic acid has remained practically constant at 13 since 1899.

Exports.—Acetic acid is not shown in the export tables of commerce and navigation. If acetic acid is exported the quantities have been small. It usually is the practice to export acetic acid in the form of acetate of lime and convert this into acetic acid at the point of consumption.

Imports Into the United States.

The imports of acetic acid have decreased from about 1,000,000 pounds in 1910 to about 28,000 pounds in 1914, and the larger part imported in 1914 was free of duty under the act of October 3, 1913. From 1914 to 1918 the imports increased and have been between 200,000 and 500,000 pounds, or less than 1 per cent of domestic production. During the fiscal year 1919 the imports show a marked increase to 1,252,649 pounds, valued at $224,482. The first six months of the calendar year 1920 shows a marked increase in imports of acetic acid to 2,029,975 pounds, valued at $259,927.

The following table shows the imports of acetic acid since 1910:

Imports of acetic acid for consumption in the United States.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910 [1]	½ cent per pound	48,014	$2,674	$360	$0.056	13.47
1910 [2]	2 cents per pound	1,021,137	82,111	20,422	.080	24.87
Total		1,069,151	84,785	20,782		
1911 [1]	½ cent per pound	46,823	3,602	351	.077	9.75
1911 [2]	2 cents per pound	32,063	2,570	641	.080	24.95
Total		78,886	6,172	992		
1912 [1]	½ cent per pound	1,387	264	10	.190	3.95
1912 [2]	2 cents per pound	76,944	5,618	1,538	.073	27.39
Total		78,331	5,882	1,548		
1913 [1]	½ cent per pound	976	199	7	.202	3.68
1913 [2]	2 cents per pound	38,672	2,837	773	.073	27.26
Total		39,648	3,036	780		
1914 [1 3]	½ cent per pound	372	91	2	.244	3.07
1914 [2 3]	2 cents per pound	7,839	593	156	.076	26.44
1914 [4]	Free	19,532	1,268		.065	
Total		27,743	1,952			
1915	Free	312,850	16,419		.052	
1916	do	504,858	53,969		.107	
1917	do	201,004	28,492		.142	
1918	do	264,997	47,673		.180	
1919 [5]	do	1,252,649	224,482		.179	
Calendar years:						
1918	do	297,323	83,907		.282	
1919	do	1,850,427	219,826		.119	
1920 (6 months)	do	2,029,975	259,927		.126	

[1] Product of specific gravity not exceeding 1.047.
[2] Product of specific gravity exceeding 1.047.
[3] From July 1 to Oct. 3, 1913.
[4] From Oct. 4, 1913, to June 30, 1914.
[5] Of this total, 1,227,988 pounds valued at $218,092 came from Canada.

PRICES.

The price of crude acetic acid (28 per cent) has increased two to three times over the normal prewar price of about 2 cents per pound. Glacial acetic acid (99 per cent) has shown a greater increase, the price in 1916, reaching a high level of about six times the normal price of about 8.5 cents per pound. From February 13, 1918, to January 1, 1919, the price of acetic acid was fixed by the Government at 15¾ cents per pound of 100 per cent acetic acid, and the price of glacial acetic acid at 19 cents per pound. During 1919 the price of the 28 per cent grade of acetic acid declined from about 5 cents per pound to 2¾ cents in July. This price was in force until about April, 1920, when there was an increase to 3.62 cents and a further increase in July to 3¾ cents per pound.

A compilation of prices on 28 per cent and 80 per cent acetic acid from Canadian and domestic trade journals shows that the price in Canada is considerably higher than the price in this country. The difference at times was as much as 100 per cent of the United States prices. Care should be exercised in drawing conclusions on the basis of trade journal quotations, as they often do not represent prices at which the larger portion of the goods are sold at.

Prices of acetic acid in the United States.[1]

[From Oil, Paint, and Drug Reporter.]

Years and month.	28 per cent in barrels, cents per pound.	Glacial, 99 per cent (in carboys), cents per pound.	56 per cent (redistilled), cents per pound.
1912.			
January	1.87–2.02	8.40– 9.00	(2)
April	1.87–2.02	8.25– 9.00	
July	2.00–2.15	8.50– 9.00	
October	2.00–2.15	8.50– 9.00	
1913.			
January	2.00–2.15	8.50– 9.00	(2)
April	2.00–2.15	8.50– 9.00	
July	2.00–2.15	8.50– 9.00	
October	2.00–2.15	8.50– 9.00	
1914.			
January	1.75–1.90	8.50– 9.00	(2)
April	1.50–1.65	7.75– 8.25	
July	1.50–1.65	7.75– 8.25	
October	1.50–1.65	7.75– 8.25	
1915.			
January	1.75–2.00	7.75– 8.25	(2)
April	1.75–2.00	7.75– 8.25	
July	2.50–2.65	10.50–11.00	
October	3.00–3.15	15.00	
1916.			
January	6.00	30.00–35.00	10.00–12.00
April	8.50–9.00	50.00	17.00–19.00
July	6.00–6.75	45.00–50.00	11.00–12.00
October	4.50–5.00	27.00–28.00	10.50–11.00
1917.			
January	4.50–5.00	30.00–40.00	12.00–14.00
April	4.50–5.00	28.00–30.00	10.00
July	5.00–6.00	35.00–40.00	11.00–12.00
October	6.50–7.50	40.00	15.00–15.50

[1] Prices are spot, wholesale, New York market.

[2] Not listed prior to 1916.

Prices of acetic acid in the United States—Continued.

Years and month.	28 per cent in barrels, cents per pound.	Glacial, 99 per cent (in carboys), cents per pound.	56 per cent (redistilled), cents per pound.
1918.			
January	5.50–7.00	34.00–40.00	11.00–12.50
April	6.00–6.50	38.00	12.00
July	5.96–6.11	19.50–19.70	10.96–10.87
October	4.91–5.16	19.50–19.75	9.32– 9.57
1919.			
January	4.91–5.16	19.50–19.75	9.32– 9.57
April	3.25–4.00	14.25–15.00	6.50– 7.75
July	2.75–3.00	12.00–12.44	6.00– 6.50
October	2.75–3.00	12.00–12.50	6.00– 6.50
1920.			
January	2.75–3.00	12.50–13.00	6.00– 6.50
April	3.62–4.37	15.50–16.20	8.15– 8.90
July	3.75–4.50	15.95–16.70	8.40– 9.15
October	3.75–4.50	15.95–16.70	8.40– 9.15

Comparison of prices of acetic acid in Canada[1] *and the United States.*[2]

Years and months.	80 per cent, cents per pound.		Commercial crude, 28 per cent, in barrels, cents per pound.	
	Canada.	United States.	Canada.	United States.
1918.				
January	25.00–30.00	.....	.....	5.50– 6.00
February	29.00–33.00	19.00–20.00	7.85– 8.50	5.50– 6.50
March	29.00–33.00	21.00–22.00	7.85– 8.50	5.50– 6.50
April	29.00–33.00	21.00–22.00	7.85– 8.50	6.00– 9.00
May	29.00–33.00	23.00–26.00	9.40– 9.50	6.00– 9.00
June	29.00–33.00	23.00–26.00	10.00–10.50	6.00–12.00
July	35.00–37.00	15.15–15.30	10.10–10.40	5.96– 6.11
August	35.00–37.00	15.15–15.30	10.10–10.40	4.91– 5.16
September	35.00–37.00	15.15–15.40	10.00	4.91– 5.16
October	35.00–37.00	15.15–15.40	10.00	4.91– 5.16
November	29.00	15.15–15.40	10.40–10.40	4.91– 5.16
December	29.00	15.15–15.40	10.40–11½	4.91– 5.16
1919.				
January	29.00	15.15–15.40	10.40–11½	4.91– 5.16
February	21½ –22½	12.00–12½	5.50– 6.50	3.25– 4.00
March	21½ –22½	12.00–12½	5.50– 6.50	3.25– 4.00
April	21½ –22½	12.00–12½	5.50– 6.50	3.25– 4.00
May	21½ –22½	11½ –12.00	5.50– 6.50	3.00– 3.50
June	21½ –22½	9½ –10.00	5.50– 6.50	2.75– 3.00
July	21½ –22½	10.14–10½	5.50– 6.50	2.75– 3.00
August	20½ –21½	10.14–10½	4.50– 5.50	2.75– 3.00
September	20½ –21½	10.00–10½	4.50– 5.50	2.75– 3.00
October	18½ –19½	10.00–10½	4.50– 5.50	2.75– 3.00
November	.....	10.00–10½	.....	2.75– 3.00
December	.....	10.00–10½	.....	2.75– 3.00
1920.				
January	18½ –19½	10.00–10½	4.50– 5.50	2.75– 3.00
February	18½ –19½	10.00–10½	4.50– 5.50	2.75– 3.00
March	18½ –19½	.....	4.50– 5.50	.....
April	18½ –19½	12.65–13.40	4.50– 5.50	3.62– 4.37
May	18½ –19½	.....	4.50– 5.50	.....
June	21.00	.....	6.25– 7.00	.....
July	21.00	13.01–13.76	6.25– 7.00	3.75– 4.50
August	21.00	13.01–13.76	6.25– 7.00	3.75– 4.50

[1] Canadian prices are compiled from Canadian Chemical Journal.
[2] Prices in United States are compiled from Oil, Paint, and Drug Reporter, and are for spot, wholesale, New York market.

Tariff History and Tariff Consideration.

Acetic acid prior to the passage of the act of 1913 was dutiable. The duty with the exception of the period covered by the act of 1894 has been specific. A lower duty was assessed on acetic acid of a specific gravity less than 1.047 and a higher duty on acetic acid exceeding this specific gravity. The act of 1894 levied an ad valorem duty of 20 per cent. The act of 1913 placed acetic acid on the free list. This resulted in an increase in imports. The imports since 1914, notwithstanding this increase, have been small in comparison with domestic production.

Canada imposes on crude acetic acid of any strength not exceeding 30 per cent a duty of 25 per cent ad valorem, and on acetic acid n. o. p. a duty of 15 cents per gallon on any strength not exceeding strength of proof (strength of proof 6 per cent of absolute acid), and 2 cents for each degree of strength in excess of proof.

This difference in the duties existing in Canada and the United States on acetic acid gives the manufacturer in Canada an advantage over the producer in this country. The Canadian producer is able to keep the price of acetic acid at a higher level than the price prevailing in the United States. The manufacturer in Canada is able to ship acetic acid into the United States, but the Canadian duty naturally prevents manufacturers in this country from competing in the Canadian markets. This competition from Canada is likely to increase, owing to the synthetic production of acetic acid from calcium carbide as described in the preceding pages.

Should a duty be levied on acetic acid in this country, an ad valorem duty would seem to be preferable, owing to the numerous strengths of acetic acid.

The following table shows the duties levied on acetic acid by the various tariff acts since the act of 1883:

Acetic or pyroligneous acid.

[Par. 387, act of 1913, free.]

Act of—		Tariff classification or description.	Rates of duty, specific and ad valorem.
Year.	Par.		
1883	12	Acid, acetic or pyroligneous acid:	
		Not exceeding the specific gravity of 1.047	2 cents per pound.
		Exceeding the specific gravity of 1.047	10 cents per pound.
1890	1	Acetic or pyroligneous:	
		Not exceeding the specific gravity of 1.047	1½ cents per pound.
		Exceeding the specific gravity of 1.047	4 cents per pound.
1894	1	Acetic or pyroligneous acid	20 per cent ad valorem.
1897	1	Acetic or pyroligneous acid:	
		Not exceeding the specific gravity of 1.047	¾ cent per pound.
		Exceeding the specific gravity of 1.047	2 cents per pound.
1909	1	Acetic or pyroligneous acid:	
		Not exceeding the specific gravity of 1.047	¾ cent per pound.
		Exceeding the specific gravity of 1.047	2 cents per pound.
1913	387	Acetic or pyroligneous acid	Free.

NOTE.—Acetic acid having a specific gravity of 1.047 contains approximately 35 per cent of actual acetic acid.

ACETONE AND ACETONE OIL.

DESCRIPTION AND USES.

Paragraph 3, act of 1913: "Acetone, 1 cent per pound."

Acetone is a clear, colorless, fragrant, low-boiling liquid. It is considerably lighter than water, weighing about 6.6 pounds per gallon. Acetone is highly inflammable and burns with a white, smokeless flame. Chemically, it is dimethyl ketone (CH_3COCH_3).

Acetone is used primarily as a solvent. It dissolves fats, resins, rubber and other gums, nitrocellulose (cordite, guncotton, pyroxylin plastics), tannins, acetylene, and it is used in storing this gas. It was in large demand during the war as a solvent in the manufacture of the British explosive cordite and for aeroplane "dopes," a coating or varnish used to protect aeroplane wings. It is one of the raw materials used in the manufacture of chloroform. For this purpose it has a strong competitor in carbon tetrachloride. It is also used as a solvent in the paint and varnish industry and in the preparation of iodoform. Acetone-chloroform, made by treating acetone and chloroform with caustic potash, is a powerful germicide, surgical dressing, and a hypnotic for internal use.

Acetone oil, which is a residue obtained in the fractional distillation and purification of acetone, has been held to be dutiable within the provision "acetone" in paragraph 3 of the act of 1913.[1] Acetone oil is principally methyl ethyl ketone. The commercial product is a yellowish-brown liquid, having a pungent, disagreeable odor. It possesses the same solvent properties as does acetone. It, however, has a higher boiling point and for this reason is preferred to acetone in some cases. It is used for purifying anthracene, one of the necessary raw materials of the dye industry. It is also purified by distillation to obtain pure methyl ethyl ketone, which is sold under the name of ketone

Methyl acetone or acetone-alcohol is the first portion of the distillate in the refining of crude wood alcohol and is a mixture of acetone, wood alcohol, and methyl acetate. It is used for solvent purposes similar to acetone and was in large demand during the war.

DOMESTIC PRODUCTION.

Process of manufacture.—Prior to the war acetone was manufactured on a commercial scale only by the dry distillation of acetate of lime. The large demands of the war for acetone as a solvent were far in excess of the quantity that could be produced by the wood-distillation industry from acetate of lime. This resulted in the development of new processes for the production of acetone based on two general principles. The first is the fermentation of various substances (corn, molasses, and kelp). The other process, which was developed solely in Canada, produces acetone from calicum carbide as the basic raw material. In addition to these processes, another process for the production of acetone as a by-product of the Burton oil-cracking process was being developed during the war. This process is still in the experimental stage, but it has promising commercial features. These various processes of manufacturing acetone are described briefly as follows:

[1] McEnany *v.* United States, 8 Ct. Cust. Appls., 329.

Acetone from calcium acetate.—On a commercial scale acetone is made by the dry distillation of acetate of lime. The calcium acetate is heated in a closed vessel to a temperature between 290° and 400° C. The volatile products are condensed and a crude distillate is obtained containing principally acetone with other ketones, acids, and aldehydes as impurities. From this crude distillate acetone is obtained by repeated fractional distillation with caustic soda and finally with sodium sulphite. Under ordinary manufacturing conditions, there is obtained 20 to 22 pounds of acetone from every 100 pounds of acetate of lime used.

In the purification of acetone by distillation there remains in the still an oily residue which is the commercial article known as acetone oil. This crude acetone oil is used as a solvent or it is purified by distillation, thus obtaining pure methyl ethyl ketone, which is also a valuable solvent.

Acetone by fermentation.—The substances used for the production of acetone by fermentation have been corn, molasses, and kelp. Acetone was produced by the fermentation of corn in this country during the war. A plant was erected at Terre Haute, Ind., which was owned and operated by the United States and British Governments under the name of the Commercial Solvents Co. The output of acetone was about 250 tons per month. Following the signing of the armistice the plant was closed down, as there was no longer a demand for acetone.

The process consisted of the fermentation of starch contained in corn to give about 1 part of acetone and 2 parts of butyl aclohol. Large quantities of butyl alcohol were produced without a market in order to supply the large profitable demand for acetone. Since then there has developed a use for butyl alcohol as a solvent in the manufacture of pyroxylin plastics, and in December, 1919, the Commercial Solvents Corporation was organized. This company purchased the plant at Terre Haute and reopened it in March, 1920, for the production of butyl alcohol primarily. The output of the combined solvents (acetone, butyl alcohol, ethyl alcohol) has been estimated at 1,000,000 pounds monthly, which would be equivalent to an output of acetone of about 300,000 pounds a month.

Acetone was produced by this process during the war in Canada at Toronto by the British Acetone Co. The output had reached at the close of the war 200 tons per month of acetone.[1] This plant since the signing of the armistice has been dismantled.

Acetone was also produced during the war by the United States Industrial Chemical Co. at Curtis Bay, Md., by the fermentation of molasses. In this process diluted molasses is fermented under suitable conditions to ethyl or grain alcohol, which is distilled from the mass. The alcohol is then converted into acetic acid by a second fermentation process which involves percolation over wood shavings carrying the proper bacteria. The resulting acetic acid is converted into acetone by passing the vapors over red-hot lime as a catalyst. The lime combines with the acetic acid to form acetate of lime, which at the temperature maintained is immediately converted into acetone. About 30 tons per day of acetic acid (100 per cent) was produced by

[1] Nathan, Col. Sir Frederic: "The Manufacture of Acetone," Jr. Soc. of Chem. Ind., London (1919), p. 271T. Also Anonymous: "Acetone from Corn Distillation," Drug and Chem. Markets (1918), Dec. 4, p. 10.

this process and converted into acetone and methyl acetate. This plant has been closed since the signing of the armistice.

The production of acetone by the fermentation of kelp was carried out by the Hercules Powder Co., near San Diego, Calif. The kelp was fermented producing acetic, butyric, and other organic acids. These acids were then neutralized with lime, forming acetate of lime and the calcium salt of the other acids present. The acetone was then produced from the acetate of lime as previously described.

Acetone from calcium carbide.—This process for the production of acetone was developed during the war in Canada at Shawinigan Falls. Calcium carbide, which is produced there in large quantities, is first treated with water to form acetylene gas, which is then combined with more water in the presence of a catalyst to form acetaldehyde. The acetaldehyde is then oxidized to acetic acid by suitable means. The acetic acid, which is of a high purity and concentration, is then converted into acetone by passing the vapors over red-hot lime. This process only operated a short time for the production of acetone, but has continued to produce acetic acid since the war.

Acetone as a by-product of oil cracking.—In the Burton process of cracking petroleum oils for the production of gasoline a waste gas, propylene, is obtained. The gas was formerly burned for fuel, but it has been recently found that propylene can be converted into acetone by chemical means. This is accomplished by first dissolving the propylene gas in a concentrated solution of sulphuric acid, this solution is then diluted forming iso-propyl alcohol. This is oxidized to acetone by passing the vapors over a catalyst. This process is patented and gives promise of commercial success as the acetone is obtained as a by-product by a fairly simple chemical process and from cheap materials. It should be able to compete with acetone made from acetate of lime.

Production, imports, and consumption.—The production of acetone has increased from 7,761,696 pounds, valued at $812,978, in 1909 to 10,425,817 pounds, valued at $1,099,585, in 1914. Although figures are not available, there was undoubtedly a large increase in production during the war owing to the demands for the manufacture of explosives and "dopes" which were used as a varnish for coating the wings of aeroplanes. The production supplies the domestic consumption as the imports are small as shown by the following table:

Imports of acetone for consumption in the United States.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914	1 cent per pound	2,760	$307	$27	$0.111	8.99
1915	do	235,917	21,105	2,359	.090	11.18
1916	do	179,497	14,424	1,794	.080	12.44
1917	do					
1918	do	148,082	26,910	1,480	.182	5.50
1919	do	443,504	80,986	4,435	.183	5.48
Calendar years:						
1918	do	351,366	66,460	3,514	.189	5.29
1919	do	240,223	41,442	2,402	.172	5.80
1920 (6 months)	do	1,102	3,569	11	3.24	.....

PRICES.

The price of acetone reached a maximum during 1916, which was three times the normal prewar price of 12 to 16 cents per pound. The price during 1918 varied from 25 to 35 cents per pound. The price of acetone and ethyl methyl ketone was fixed by the Government on December 24, 1917, at 25½ cents per pound and the price of methyl acetone at 86 cents per gallon. On February 20, 1918, the price of methyl acetate was fixed at 21 cents per pound. These prices were in force until January 1, 1919.

A comparison of price quotations in Canada and the United States shows that the price in Canada was higher (except May, June, and July, 1919) than the price prevailing in this country. This difference often amounted to 100 per cent of the price in the United States.

Prices of acetone and allied solvents in the United States.

[From Oil, Paint, and Drug Reporter, New York.]

	Acetone per pound.	Acetone oil, light, per pound.	Acetone oil,[1] heavy, per pound.	Methyl acetone per gallon [2,3]	Ketone ethyl methyl per gallon [4]	Methyl acetate per gallon.
1912.						
January	$0.14 –$0.16					
April	.16 – .17					
July	.17 – .17½					
October	.17 – .17½					
1913.						
January	.16½– .17¾					
April	.16 – .17					
July	.15½– .16¾					
October	.15½– .16					
1914.						
January	.12 – .12½					
April	.10½– .11½					
July	.10½– .11½					
October	.11½– .12					
1915.		(5)	(5)	(6)	(6)	(6)
January	.17 – .20					
April	.21 – .23					
July	.25 – .27					
October	.30 – .33					
1916.						
January	.35 – .40					
April	.46 – .46					
July	.40 – .42					
October	.22½– .23					
1917.						
January	.22½– .23					
April	.27½– .28½					
July	.32½– .33½					
October	.35 – .36					
1918.						
January	.35 – .36	$1.35–$1.50	.....	$1.55 –$1.60	$2.05 –$2.10	.....
April	.35 – .36	1.35– 1.50	.....	1.55 – 1.60	2.05 – 2.10	.....
July	.25½– .25¾	1.35– 1.50	.....	.99 – 1.00	2.05 – 2.10	.....
October	.25½– .25¾	1.65– 1.70	$0.90–$0.95	.985 – .99	.25½– .25¾	.....
1919.						
January	.20 – .20¼	1.65– 1.70	.90– .95	1.00 – 1.01	.20½	$0.21–$0.22
April	.15½– .16	1.65– 1.70	.90– .95	1.00 – 1.01	.20¼	.21– .22
July	.13½– .14[7]	1.35– 1.40	.75– .80	.90 – 1.00	.16	.21– .22
October	.13½– .14[7]	1.35– 1.40	.75– .80	.90 – 1.00	.16	.21– .22
1920.						
January	.13½– .14[7]	1.50– 1.55	.90– .95	.90 – 1.00	.15½– .16	.21– .22
April	.19¾– .20[7]	1.50– 1.55	.90– .95	1.15 – 1.20	.15½– .16	.30– .32
July	.21 – .22[7]	1.50– 1.55	.90– .95	1.15 – 1.20	(8)	.30– .32

[1] Car lots.
[2] Price of methyl acetone was fixed by the Government Dec. 24, 1917, at 86 cents per gallon.
[3] Price for methyl acetone was first quoted on pound unit. This was error, and all quotations should be per gallon. See letter Apr. 15, 1919, from Oil, Paint, and Drug Reporter.
[4] Price of ethyl ketone fixed by the Government Dec. 24, 1917, at 25½ cents per pound. Expired Jan. 1, 1919.
[5] Not listed prior to 1918.
[6] Not quoted prior to 1918.
[7] Drum, car lots, less car lots 15 and 16.
[8] Nominal.

Comparison of prices of acetone in Canada and United States.

	1917		1918		1919		1920	
	Canada.[1]	United States.[2]	Canada.[1]	United States.[2]	Canada.[1]	United States.[2]	Canada.[1]	United States.[2]
January			36-43	35 -36	50	20 -20½	18½-23½	13½-14
February			41-43½	39 -40	24 -27	15½-16	18½-23½	
March			50-55	35 -36	24 -27	15½-16	18½-23½	
April			50-55	35 -36	24 -27	15½-16	18½-23½	19½-20
May	80	29½-30½	50-55	35 -36	15½	15½-16	18½-23½	
June	60	29½-30½	50-55	25½-24½	15½	15½-16	18½-23½	
July	60	32½-33½	55-56	25½-25½	15½	13½-14	18½-23½	21 -22
August		33 -34	Nominal.	25½-25½	18½-23½	13½-14	18½-23½	21 -22
September	60	35 -36	Nominal.	25½-25½	18½-23½	13½-14		
October	75	35 -36	50	25½-25½	18½-23½	13½-14		
November	43	35 -36	50	25½-25½				
December	36-43	35 -36	40	25½-25½				

[1] Prices compiled from the Canadian Chemical Journal. See letter (insert) from this publication of Mar. 17, 1919.
[2] Prices compiled from the Oil, Paint, and Drug Reporter, wholesale, spot, New York market.

Tariff History and Considerations.

Acetone was first mentioned by name in the act of 1913 as dutiable at 1 cent per pound and includes acetone oil.

Canada at the present time levies a duty of 30 per cent ad valorem on acetone. The equivalent ad valorem duty in this country has never amounted to more than 12.5 per cent.

As pointed out, there have been many new developments in the manufacture of acetone during the war. The question arises whether these new processes will be able to compete with acetone made from acetate of lime. All of the plants operating the fermentation processes were closed immediately after the signing of the armistice. The process for the production of acetone and butyl alcohol by the fermentation of corn was again put into operation early in 1920 at Terre Haute, Ind. The ability of this process to operate depends on the utilization of the butyl alcohol in the manufacture of pyroxylin plastics. As the use of butyl alcohol increases this process will offer increased competition to acetone by the wood chemical industry from acetate of lime. This competition is domestic and has no bearing on tariff considerations.

The process of producing acetone from waste gases of the Burton oil-cracking process seems to possess advantages which will enable it to compete with acetone made from acetate of lime. In fact, domestic manufacturers of acetone have expressed more fear of competition from this process than from acetone produced by the fermentation of corn. This process will also offer competition from domestic sources rather than from foreign countries.

Under the present existing rates of duty in Canada and in the United States the Canadian manufacturer of acetone possesses a material advantage over the domestic producer. Canada imposes a duty of 30 per cent on the importation of acetone, while the domestic duty of 1 cent per pound on acetone has not amounted to more than 12.5 per cent ad valorem. The difference in duty enables the Canadian manufacturer to sell acetone in Canada at a price considerably above the price prevailing in this country. The high Canadian duty naturally would prevent shipment of acetone from this country to Canada in competition with acetone produced in Canada, while the lower duty in this country would place the domestic producers at considerable disadvantage in case of sharp competition.

FORMALDEHYDE OR FORMALIN.

Description and Uses.

Paragraph 32, act of 1913: "Formaldehyde solution containing not more than 40 per centum of formaldehyde, or formaline, 1 cent per pound."

Formaldehyde, or formic aldehyde, is a chemical compound which at ordinary temperatures and pressures is a gas. It has the chemical formula HCHO. Formaldehyde is sold commercially in two different forms. Formalin (not formaline) is a water-alcohol solution containing about 40 per cent, by volume, of formaldehyde. This solution contains, by weight, 36.5 per cent of formaldehyde, 12 to 14 per cent of wood alcohol, and 50 to 52 per cent of water. The wood alcohol is added to prevent the formaldehyde from polymerizing to form solid paraformaldehyde. Water will dissolve up to 52 per cent of formaldehyde gas, but for technical reasons it is not feasible to make a solution approaching this concentration. When a solution of formaldehyde is heated in the presence of dehydrating agents, three molecules of the formaldehyde combine (polymerize) to form trioxymethylene. Paraformaldehyde, or "paraform," which is a white, crystalline solid, is produced by evaporation of solutions of formaldehyde. It is a polymerization product of formaldehyde containing an unknown number of molecules of formaldehyde. Paraform, when heated, evolves formaldehyde gas, and this property is made use of in the disinfecting of sick rooms and sick-room utensils, clothing, and linen. The commercial article contains about 95 per cent, by weight, of pure formaldehyde, or over twice the quantity contained in an equal weight of formalin.

The uses of formaldehyde are many and varied. It is used as an antiseptic, disinfectant, preservative, for industrial chemical purposes, and in the arts. For disinfectant purposes it is largely used in the solid form (paraform). It is used in embalming and in the preservation of corpses, gelatine films of photographic plates. Formaldehyde is also used for reducing gold and silver salts, and this property is largely made use of in the silvering of mirrors. Formaldehyde has an important industrial use in the manufacture of hexamethylenetetramine, which is an important drug and which is used in the manufacture of "Redmanol," a synthetic resinlike product. Formaldehyde is also used directly in the manufacture of other synthetic resins known under different trade names, such as "Bakelite," "Condensite," and others. These synthetic products have a wide and varied industrial usage. It is also used in the manufacture of certain coal-tar dyes. It is used in large quantities for sterilizing seed, particularly wheat to prevent smut. Formaldehyde is used in the manufacture of synthetic tanning agents and in hydrosulphites and sulphoxalates used as discharge agents in textile printing.

Domestic Production.

Process of manufacture.—Formaldehyde is a product of the further manufacture of wood alcohol. For formaldehyde manufacture a very pure grade of wood alcohol (containing less than 0.1 per cent of acetone) is required. Formaldehyde is produced by passing a mixture of air and wood alcohol over a hot copper gauze, which causes the alcohol to be oxidized to formaldehyde. The conversion of the wood alcohol evolves considerable heat, which is more than sufficient to

keep the copper gauze at the desired temperature. It is usually necessary to cool the copper gauze, as too high a temperature causes further oxidation of the formaldehyde to undesirable products. The resulting vapors of formaldehyde, water, and wood alcohol then enter a separator in which, by a washing process, a solution of formaldehyde is produced. This solution is concentrated to the desired strength of formaldehyde by distilling off the excess of wood alcohol. The unconverted methyl alcohol is returned to the process. The process is practically automatic and requires comparatively little labor for its operation. The yield of formaldehyde is about 90 per cent of theory.

Geographical distribution.—The principal manufacturers of formaldehyde are located in New Jersey and at Niagara Falls, N. Y. In 1914 there were only three establishments manufacturing formaldehyde.

Production and consumption.—The production of formaldehyde increased from 3,794,486 pounds, valued at $363,817, in 1909 to 8,426,427 pounds, valued at $655,174, in 1914. This increase was in existing plants, as there were only three plants in both 1909 and 1914. The War Industries Board [1] estimates the annual production as 18,000,000 pounds in 1917. This represents an increase to more than twice the production in 1914. The domestic production supplies practically all of the consumption, as the imports are very small.

Exports.—Formaldehyde is not listed in the export tables of Commerce and Navigation prior to the 1918 fiscal year, when the exports of this article were valued at $866,038. About 50 per cent of the export was to France, with the United Kingdom, Italy, and Japan taking the larger part of the remainder. The quantity is not given, but on the basis of the 1918 import price ($0.177 per pound) this value would represent about 4,800,000 pounds of formaldehyde solution. During the calendar year 1919 the exports increased to $1,270,797. The United Kingdom, Japan, and Italy, in order, were the principal customers. Exports for nine months of 1920 were $2,343,157.

IMPORTS INTO THE UNITED STATES.

The imports of formaldehyde have been sporadic and are small when compared with the production in this country, even in view of the fact that the imports in 1918 were about ten times the 1917 import. The following table shows the imports of formaldehyde since 1910:

Formaldehyde—imports for consumption.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1908	25 per cent	21,815	$5,978	$1,495	$0.274	25.00
1909	do	34,143	9,842	2,460	.288	25.00
1910	do	34,269	9,394	2,348	.274	25.00
1912	do	12,303	3,298	824	.268	25.00
1914	1 per cent per pound	14,228	1,443	142	.101	9.86
1915	do	7,700	814	77	.106	9.46
1916	do	79,857	8,054	798	.101	9.92
1917	do	23,935	2,349	239	.098	10.19
1918	do	205,897	36,495	2,058	.177	5.64
Calendar year:						
1918	do	148,798	25,548	1,488	.171	5.82
1919	do	502	113	5	.225	4.44
1920 (6 months)	do	195,538	92,902	929	.....	.....

[1] War Industries Board, History of Prices During the War, Bulletin No. 57.

PRICES.

The price of formaldehyde (40 per cent solution) had more than doubled when the Government fixed the price on February 2, 1918, at 15¼ cents per pound, naked, f. o. b. shipping point. The spot New York price prior to the war was practically constant at about 8½ cents. This Government price was in effect until January 1, 1919. The price of formaldehyde, with the removal of Government control, immediately increased to over 20 cents per pound, which was the price quoted during the last three quarters of 1919. During 1920 the price increased to a maximum of 58 cents in the second quarter of the year. There was then a decline to 44 cents in October, 1920.

The following table gives the spot New York market price on formaldehyde by quarters since 1912:

Formaldehyde, 40 per cent solution.

[Par. 32, act of 1913, 1 cent per pound. Prices (wholesale). Cents per pound, spot, New York. Data from Oil, Paint and Drug Reporter.]

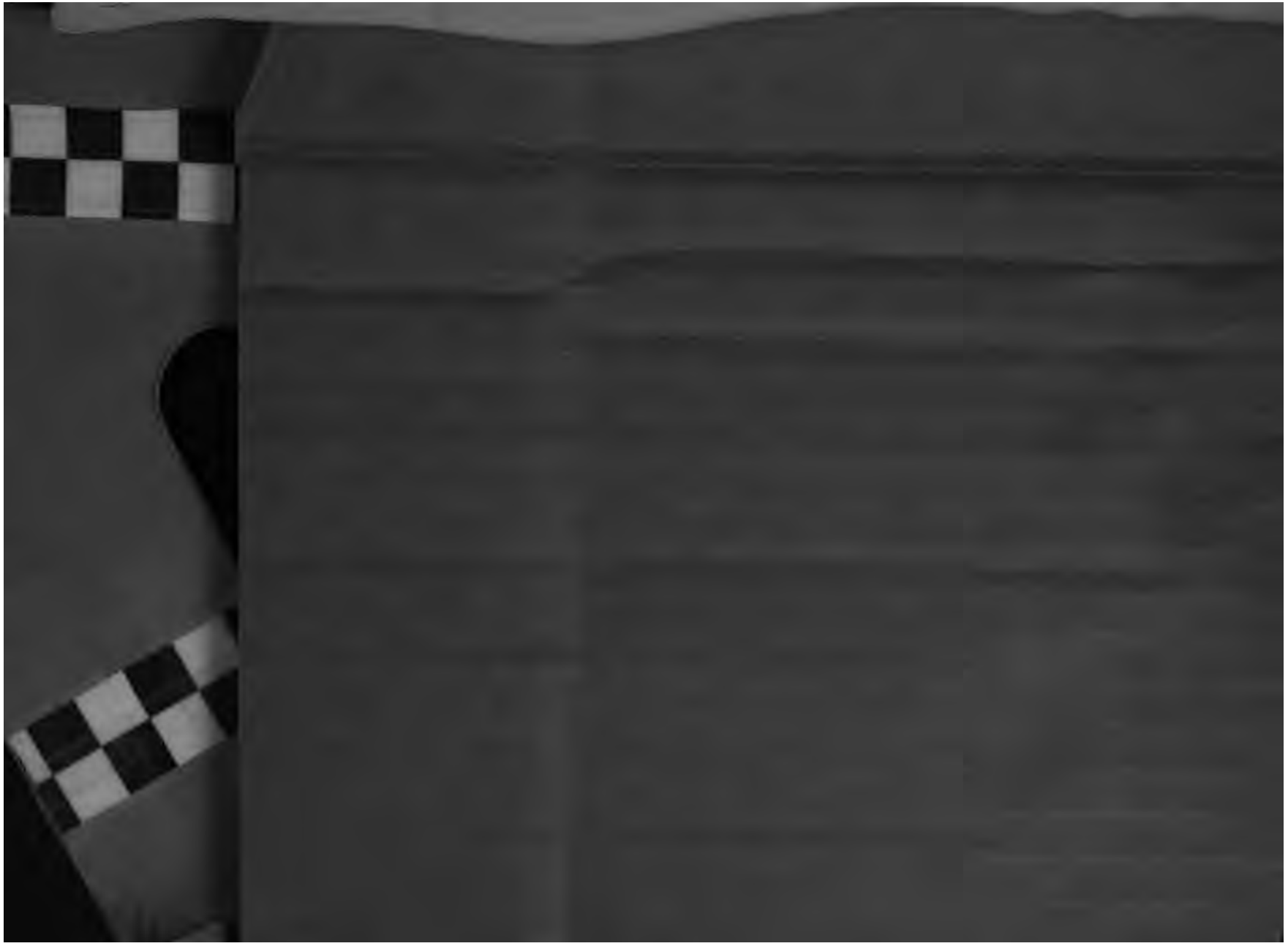
	1912	1913	1914	1915	1916	1917	1918	1919	1920
January	8½–9½	8½–9½	8½–9½	8½–9½	9½–10	12 –12½	19½–20	[1] 16½	35–40
April	8½–9½	8½–9½	8½–9½	8½–9½	11 –12½	13	19 –20	22½–23	58–63
July	8½–9½	8½–9½	8½–9½	8½–9½	13½–14	17 –18	[1] 16½	20 –22	55–57
October	8½–9½	8½–9½	8½–9½	9½–10	10 –11	15½–17	[1] 16½	22½–23	44–50

[1] Government price, f. o. b. factory. Fixed on Feb. 12, 1918, at 15¼ cents per pound, naked, f. o. b. point of shipping. Expired on Jan. 1, 1919.

TARIFF HISTORY AND CONSIDERATION.

Formaldehyde was first mentioned by name in the act of 1913 as dutiable at 1 cent per pound. Formaldehyde was dutiable prior to this time as a chemical compound not specially provided for. The duty of 1 cent per pound has been equal to between 5 and 10 per cent ad valorem.

In considering duty on formaldehyde, it would be well to make provision for the two forms of formaldehyde which are articles of commerce. The present wording covers only a solution of formaldehyde "containing not more than 40 per centum of formaldehyde." This restricting clause serves no useful purpose but increases chances of litigation. It would facilitate custom classification if only the wording "Formaldehyde solution" or "formalin" was used. The present spelling "formaline" is incorrect, the "e" should be dropped. In addition a provision for solid formaldehyde, paraformaldehyde, or "paraform" would seem advisable. The ratio between the formaldehyde content of formalin and paraform is about as 37 to 95.



UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPH 64 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

THE POTASH INDUSTRY

Paragraph 64:
- **Potassium—**
  - **Bicarbonate, Refined**
  - **Chlorate**
  - **Chromate and Bichromate** (See also par. 67)
  - **Nitrate, Refined** (See also par. 67)
  - **Permanganate**
  - **Prussiate, Red and Yellow** (See also par. 67)

Paragraph 580:
- **Potassium—**
  - **Crude of "Black Salts"**
  - **Carbonate**
  - **Cyanide** (See also par. 67)
  - **Hydroxide** (Hydrate)
  - **Muriate**
  - **Nitrate, Crude** (See also par. 67)
  - **Sulphate**

REVISED EDITION

WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

POTASH

POTASH.

SUMMARY.

IMPORTANCE OF THE INDUSTRY.

Potash has no direct military significance, with the exception of the nitrate and chlorate of potash which are used in certain explosive mixtures. These are, however, of secondary importance in comparison with other explosive materials.

About 95 per cent of all potash is used for fertilizer purposes. It is used principally in the growing of cotton, tobacco, potatoes, citrus fruits, and garden truck. Very little is used on corn, wheat, or other grains. The principal market is located in the South Atlantic States. The scarcity of potash during the war has demonstrated that much of the potash was used, before the war, where it was not needed. On the other hand, there has been evidence of potash hunger with certain crops growing on certain soils.

FOREIGN AND DOMESTIC RESOURCES.

Prior to the war Germany held an almost complete monopoly on the world's trade in potash. This monopoly was made possible by the possession of the only known large deposits of soluble potash salts, located in the vicinity of Stassfurt, Germany, and near Mulhausen in Alsace. The annual output of the Stassfurt mines has been about 1,000,000 tons per year of actual potash (K_2O). The deposits of Alsace are equal in quality to the Stassfurt deposits, although they are much smaller. However, they are of sufficient size to supply the world's demand for many decades. With France now in possession of Alsace, sharp competition between these two deposits for the world's trade in potash may be expected.

Before the outbreak of the war there was practically no potash produced in this country. The domestic production during the war has been developed until in 1918 the output from all sources was about 54,000 short tons of actual potash (K_2O), or about 20 per cent of our normal prewar consumption. About one-half of the domestic production in 1918 came from the saline lakes in Nebraska. The estimated productive capacity of the domestic industry in 1919 was 100,000 short tons of actual potash, but because of the uncertain market the actual production amounted to only 32,418 tons. It is estimated that the resources of the Nebraska lakes will be depleted

in about 10 years at the rate of the 1918 production. Searles Lake, in California, is estimated to contain as much as 20,000,000 tons of actual potash.

DOMESTIC SUPPLIES.

For several years before the outbreak of the war the imports of potash salts averaged about 1,000,000 tons. This quantity represented a normal prewar consumption of approximately 270,000 short tons of actual potash (K_2O). Over 99 per cent of this import came from Germany.

The domestic supplies of potash during the war have originated from many varied sources and by different processes. The source which gives the greatest promise of permanency under competitive conditions is the dust from cement mills. The collection of the dust abates a nuisance and gives a valuable by-product. If practiced by all cement mills it is probable that 75,000 tons of actual potash could be obtained annually, or nearly one-third of the prewar consumption.

The collection of potash from the dust of blast furnaces, although the commercial recovery has not been developed to the same extent as in the case of cement dust, offers a possible permanent source of potash. Apparently only the Southern and imported Cuban iron ores contain sufficient potash to make its recovery on a commercial scale feasible. A production of 20,000 tons of actual potash from this source may be possible.

It is questionable if the recovery of potash on the present scale from the natural brines of Nebraska and California, from kelp, and from the leucite hills of Wyoming, can be continued after the resumption of foreign competition. The raw materials are not as suitable for cheap production of potash as are the minerals of the Stassfurt and Alsace deposits. The sources are far from the chief markets (South Atlantic States), which places them at a large disadvantage in regard to freight rates.

Many of the other processes for recovering potash are still largely in an experimental state.

THE POTASH INDUSTRY.

THE SITUATION BEFORE THE OUTBREAK OF THE WAR.

The salts of potash and of soda are so similar that for nearly all purposes except fertilizer one can be substituted for the other. In many cases the soda salt is both better and cheaper. In others, the potash salt is used because it has an advantage sufficient to counterbalance the prevailing difference in price. Until about 1800, potash was obtained entirely from wood ashes. It was cheaper and more plentiful than soda, then obtained exclusively from the ashes of seaweed. Glass and soap made at that time were chiefly potash glass and potash soap. The development of the Leblanc process for making soda from salt during the first quarter of the nineteenth century made soda cheaper than potash, and the result was that the consumption of soda increased more rapidly than that of potash. About 1857 large deposits of soluble potash salts were discovered underlying an extensive area in central Germany. In 1860 the usefulness of these salts as fertilizer was discovered, and in 1861 the first factory for refining the crude salts was erected.

The rapid growth of the industry is shown by the following figures for the output of the German mines. Germany's sales of pure potash are shown graphically in the figure on page 156.

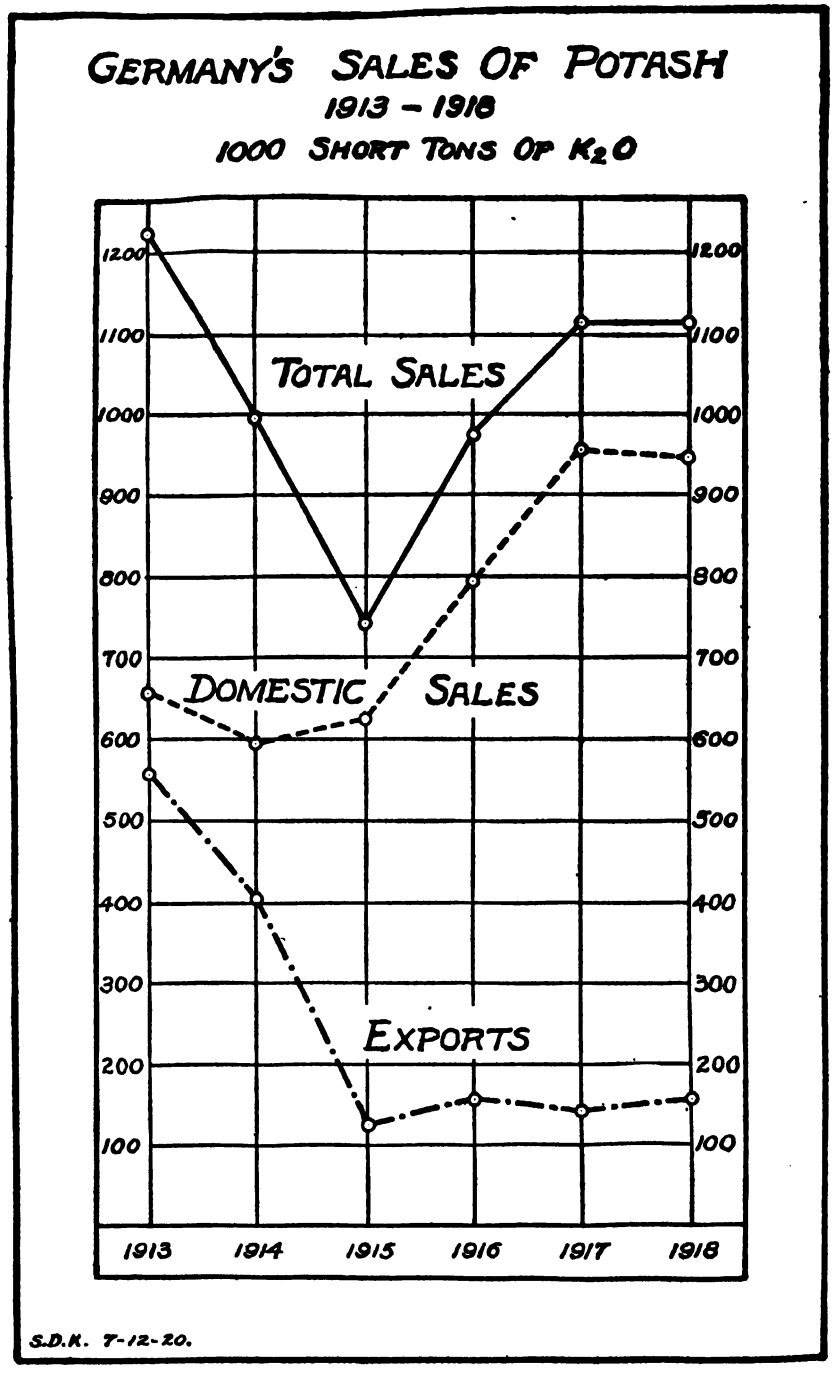
Production of potash in Germany.[1]

[In terms of actual potash[2] (K_2O) expressed in metric tons of 2,204 pounds.]

Year.	Metric tons.	Year.	Metric tons.
1870	30,000	1914	904,137
1880	68,550	1915	679,975
1890	122,302	1916	883,696
1900	303,610	1917	[3]1,004,285
1910	857,883	1918	[4]1,001,171
1911	939,927	1919	[5]858,439
1913	1,110,274		

[1] The Potash Supply with Special Reference to the United States, a pamphlet published by the German Potash Syndicate, Berlin, p. 32, 1913. The Potash Industry, a pamphlet published by the German Kali Works (Inc.), New York, pp. 35, 39, 40, 1916.
[2] The actual weight of crude salts mined is about ten times the figures here given, since the crude salt averages about 10 per cent of actual potash.
[3] Sales according to Frankfurter Zeitung July 10, 1918, published in Commerce Reports, Oct. 9, 1918.
[4] The German Potash Industry, British Board of Trade Journal, Mar. 18, 1920.
[5] Oil, Paint, and Drug Reporter, Feb. 23, 1920, p. 55.

More than one-half of the total production is consumed in Germany and a little less than one-quarter in the United States. The normal prewar consumption of the United States may be taken as approximately 270,000 short tons of actual potash per year.


GERMANY'S SALES OF POTASH
1913 – 1918
1000 SHORT TONS OF K_2O
TOTAL SALES
DOMESTIC SALES
EXPORTS
1200
1100
1000
900
800
700
600
500
400
300
200
100
1913
1914
1915
1916
1917
1918
S.D.K. 7-12-20.

Actual potash (K_2O) content of potash salts imported for consumption in the United States, 1905–1918.

[From Mineral Resources of the United States, 1918.]

Year.	Short tons.	Year.	Short tons.
1905	129,084	1912	253,678
1906	155,974	1913	270,720
1907	144,351	1914	207,089
1908	136,057	1915	48,867
1909	173,220	1916	7,885
1910	279,780	1917	8,100
1911	274,446	1918	7,967

The potash in these German deposits exists in the form of the minerals, sylvinite (potassium chloride or muriate), carnallite (double chloride of potassium and magnesium), kainite (double sulphate of potassium and magnesium), associated with common salt, anhydrite (calcium sulphate), and kieserite (magnesium sulphate), some bromides and borates, and many other minerals of minor importance. A German geologist has estimated that the supply is sufficient to provide for a consumption of 5,000,000 tons per year for 600,000 years.

The salts are mined by methods similar to the methods of mining coal, and the costs, therefore, probably approximate the cost of coal mining. Much of it, especially the kainite, is put on the market for fertilizer without other treatment than grinding and bagging. Imports of kainite into the United States averaged about 500,000 tons per year.

Carnallite is present in the deposits in abundance and is the material from which the muriate is made by a simple and cheap process involving primarily crystallization from water.

The industry is controlled by a syndicate in which the Prussian Government is a partner. The syndicate has been supported by the German Government to the extent of compelling all mines to join it. The price of potash salts has been maintained much above a competitive price, but low enough to keep an almost complete monopoly of the world's markets.[1]

[1] See Tosdal, H. R.: The Kartell movement in the German potash industry, Quarterly Journal of Economics, vol. 28, pp. 140–190; also Report on Fertilizer Industry, pp. 104–119, published by Federal Trade Commission, 1916.

Total quantities of crude salts extracted from mines of the German Potash Syndicate.[1]

Year.	Carnallite.	Kieserite.	Kainite, hartsalz, and schönit.	Sylvinite.	Total.
	Metric tons.	*Metric tons.*	*Metric tons.*	*Metric tons.*	*Metric tons.*
1890	838,526	6,951	401,870	31,916	1,279,264
1895	782,944	3,012	669,531	76,097	1,531,585
1900	1,697,803	2,047	1,189,394	147,791	3,037,035
1901	1,860,189	2,335	1,432,136	190,034	3,484,694
1902	1,705,664	1,821	1,354,528	188,820	3,250,834
1903	1,844,036	1,553	1,582,867	196,140	3,624,597
1904	1,911,166	1,055	1,906,823	234,455	4,053,499
1905	2,239,709	2,730	2,405,536	230,621	4,878,598
1906	2,263,197	9,190	2,754,021	284,943	5,311,352
1907	2,534,788	10,359	2,788,973	304,143	5,638,261
1908	2,768,793	18,473	2,921,712	305,282	6,014,261
1909	3,280,726	7,387	3,268,290	344,749	6,901,153
1910	3,582,885		4,577,893		8,160,778
1911	4,441,664		5,264,843		9,706,507
1912	5,281,642		5,7°8,371		11,070,014
1913	5,302,350		6,305,160		11,607,510

[1] Federal Trade Commission report on the fertilizer industry.

Deposits similar to the Stassfurt mines were discovered in 1904 in Upper Alsace near Mulhouse. The total reserves of these deposits, which consist almost entirely of the chlorides of sodium and potassium, have been estimated at one and one-half billion tons of crude salt, roughly equivalent to 300,000,000 tons of potash (K_2O).[2] The exploitation of the mines began in 1910, and in August, 1914, 14 of the 18 mines were controlled by the German Kali Syndicate. Inland transportation facilities either by rail or barge are ample and when the military authorities turn the mines over to private control and necessary capital is provided to bring the production to a more efficient basis, the Alsatian deposits will offer severest competition to the German syndicate. The German monopolistic control over prices is definitely broken and the American consumer will benefit thereby.

The Alsatian production during 1919 was 591,471 tons, an increase of almost 70 per cent over the production in 1913, which amounted to 350,341 tons. The production in 1919 was equivalent to 96,546 tons of pure potash. Of this amount 30 per cent was exported to the United States.

The Stassfurt and Alsatian deposits were, at the outbreak of the European war, the only known deposits which were soluble in water and present in solid form. They are readily available for use as fertilizer and for industrial purposes. These deposits gave the control of the world's potash trade to Germany.

SIGNIFICANCE OF POTASH IN AGRICULTURE AND IN CHEMICAL INDUSTRIES.

Compounds of potassium or potash, as it is commercially called, occur in great abundance and widely scattered areas. F. W. Clarke, of the United States Geological Survey, estimates that 3 per cent

[2] Binder, Felix: L'Industrie de la Potasse de la Haute-Alsace, Dec. 24, 1917.

of the outer 10 miles of the earth consists of the element potassium. All but a small fraction of this enormous amount of potash occurs in the mineral feldspar and other silicate rocks. The ocean contains soluble potash salts in enormous aggregate amounts, but in such dilute solution that very little has been recovered commercially from this source.

Potash in the form of feldspar and other silicate rocks is insoluble and not directly available for agricultural or chemical uses. Feldspar is a complex silicate of potassium, sodium, and aluminum, in which the potash is held in such firm chemical combination that large amounts of energy are necessary to decompose it. Any process of decomposing feldspar is, therefore, necessarily more expensive than the utilization of the readily soluble potash salts from the German deposits. Many attempts have been made to recover potash from feldspar, but none have successfully competed with potash from other sources. There is no hope that such a process of decomposing feldspar can be successful in competition with the other sources of potash unless the aluminum and silica are recovered in salable form (as Portland cement, or as pure oxide of aluminum or metallic aluminum) and of a value sufficient to offset the high cost of the process which makes the potash in a sense a by-product.

Potash is present in all tillable soils and is essential to the growth of all plants. In the form of feldspar, it is insoluble and not directly available to plants. Feldspar in soil, however, decomposes, even though slowly, gradually making the potash available. The process requires centuries for completion, and thus maintains the fertility over long periods. The productiveness of some soils is limited by the available or soluble potash content. On such soils the addition of potash salts, which are soluble and therefore readily available to plants, may increase the value of the crop by an amount greater than the cost of the added potash salts. The question of whether the use of fertilizer containing potash is an economic advantage depends on the nature of the soil, the crop to be grown, the cost of the potash, and the price received for the crop. Potash is especially needed on muck soils; its addition to the black loam of the middle western prairies is, however, unnecessary and of doubtful economic advantage, especially for grain crops. The crops which show the greatest need of potash are cotton, potatoes, tobacco, and citrus fruits. In the United States the cotton crop needs and has in the past taken by a substantial margin more potash than any other crop. Some soils in the cotton-growing section yield good crops without the addition of potash, but a large proportion of the cotton-growing area is greatly benefited by its use. The lack of potash in the soil can not be compensated for by the addition of other fertilizers. Phosphates, nitrates, and lime, or other fertilizer material serve a distinct and

largely independent function in the growth of the plant. The greatest market for potash in the United States has been in the South Atlantic States.

Germany has consumed more potash than all the rest of the world combined. The German Potash Syndicate has been active in stimulating the sale of potash throughout the world by means of advertisements, demonstration farms, and exhibits. The following statistics of the consumption of actual potash (K_2O) in agriculture, not including industry, in the most important consuming countries, are taken from German official sources. The quantity is given in short tons.

World's consumption of potash in agriculture, by countries, 1910–1917.[1]

Country.	1910	1911	1912	1913	1914	1915	1916	1917
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Germany	395,269	464,575	509,722	589,713	531,990	572,232	748,617	917,820
Belgium	9,886	10,011	12,040	14,501	11,408	11,742	11,670	15,878
Holland	32,338	37,812	43,421	47,826	46,188	31,972	62,535	48,225
France	25,134	29,115	34,860	36,426	21,327	65	1	1
United Kingdom	20,084	22,992	25,756	25,572	12,792	.....	.....	.....
Luxemburg	118	193	312	442	511	1,632	1,800	2,384
Austria	12,996	16,572	20,767	23,072	23,404	18,611	27,820	32,724
Hungary	1,477	3,019	4,110	4,508	3,210	2,835	3,514	3,018
Switzerland	3,055	2,945	3,851	3,639	4,438	2,785	7,556	5,206
Italy	6,161	6,667	8,025	6,990	4,880	521	.....	.....
Russia	16,003	18,787	25,762	24,920	16,883	1,424	3,972	1,097
Spain	8,083	10,830	9,910	9,122	3,502	252	.....	.....
Portugal	870	1,214	1,248	1,365	455	60	.....	.....
Sweden	18,290	19,197	22,737	21,465	26,671	24,909	24,968	30,536
Norway	1,937	2,511	3,774	3,953	5,271	3,967	4,379	30,536
Denmark	4,804	6,195	6,607	8,222	8,212	8,553	18,260	30,536
Finland	1,080	1,459	1,565	1,766	684	.....	.....	.....
Balkan States	152	414	408	218	806	200	53	.....
Asia	3,531	5,137	6,406	6,281	4,633	707	38	40
Africa	1,808	2,523	3,455	4,807	2,126	121	.....	.....
United States	139,063	206,141	233,446	254,859	167,749	5,551	.....	.....
Canada			307	1,513	337	.....	.....	.....
Remainder of North and South America	8,345	7,467	8,614	10,140	7,271	.....	.....	.....
Australia	1,996	1,970	2,883	2,739	1,187	.....	.....	.....

[1] This table and the one which follows it are taken from an article on the German potash industry during the war, published Nov. 1, 1919, in the Fortnightly Information Review of the American Chamber of Commerce in France. The figures for 1918 are from an official publication of the German Foreign Office.

The following statistics, from the same sources, show the percentage of German potash used in agriculture and in the industries, in short tons of actual K_2O:

German potash used in agriculture and in industry, 1910–1918.

Year.	Domestic sales.	Foreign sales.	Total.	Value calculated on legal prices.	Value at par.	Used in agriculture.	Used in industry.
	Tons.	*Tons.*	*Tons.*	*Marks.*		*Per cent.*	*Per cent.*
1910	460,618	346,473	807,091	133,800,000	$31,800,000	88.3	11.7
1911	527,822	441,941	969,763	160,100,000	38,100,000	90.5	9.5
1912	581,422	524,514	1,105,936	186,400,000	44,400,000	89.5	10.5
1913	664,711	556,695	1,221,406	202,500,000	48,200,000	90.4	9.6
1914	591,590	402,797	994,387	164,500,000	39,200,000	91.2	8.8
1915	623,807	123,947	747,754	111,700,000	26,600,000	92.0	8.0
1916	797,548	174,825	972,373	163,900,000	39,000,000	94.1	5.9
1917	958,625	146,084	1,104,709	230,500,000	54,900,000	95.7	4.3
1918	945,688	156,143	1,191,831	300,000,000	71,400,000	95.7	4.3

Potash salts are also used for many industrial purposes, but before the war these uses consumed only about one-tenth of the total. For all of these industrial purposes (but not for fertilizer) the potash salt competes with the corresponding soda salt. The potash salt will only be used if it has a special advantage which justifies the payment of a higher price. Since the outbreak of the European war the difference in price between the potash and soda salts has increased. This has caused a marked substitution of soda salts for potash salts in many cases.

Although most glass is soda glass, potash (as carbonate) is used for certain varieties of glass, especially cut-glass tableware (flint glass), electric-light bulbs, and certain varieties of optical glass. Potash tends to give the glass a lower melting point and to make it more refractive than does soda.

The consumption of soda in making soap far exceeds the consumption of potash, but potash (as hydroxide) is used in some varieties of soap, especially wool-scouring soaps.

There are a number of other salts of potash which are preferred for use in the chemical industries to the corresponding soda salts, because the potash salt is more readily crystallized or shows less tendency to become moist by absorption of water from the air. This is true of the permanganate, chlorate, and perchlorate, bromide, iodide, chromate and bichromate, ferrocyanide and nitrate. (See p. 172ff, for discussion of the uses of the salts.) The relative advantage of the potash salt over the soda salt varies greatly in different cases, and therefore the difference in price which consumers are willing to pay varies according to the use the soda or potash salt is to serve. At one time cyanide was usually marketed as the potash salt, but the soda salt had practically driven potassium cyanide out of the market even before the outbreak of the war.

DEVELOPMENT OF THE INDUSTRY IN THE UNITED STATES FROM BEGINNING OF THE WAR TO SIGNING OF THE ARMISTICE.

At the outbreak of the war the United States, in common with the rest of the world, was practically dependent on Germany. Imports into the United States for the fiscal year ending June 30, 1914, had been the greatest on record, a total of 1,085,004 tons, valued at $16,350,019. During the second half of 1914 imports continued, although in greatly reduced volume. At the end of 1915, Germany put an embargo on the further exportation of potash salts. This was followed by a rapid advance in the price. The grade of muriate of potash commonly used for fertilizer (80 to 85 per cent pure), which had sold in New York at $39.07 on July 1, 1914, rose to $230 on July 1, 1915, and to $475 on January 1, 1916. Crude carbonate

of potash, which was worth 3 cents and a fraction per pound at the outbreak of the war, rose to 20 cents by the middle of 1915 and to 50 cents by the end of 1915.

As a consequence of the shortage and high prices for potash salts, the creation of an American potash industry aroused keen interest. During 1915 there was great activity in experimental work and in the erection of plants for the production of soluble potash salts from American sources. The actual output during 1915 was, however, very small, certainly less than one-half per cent of our normal consumption. Many of the projects started in 1915 reached the stage of commercial production in 1916. The production during 1916 was, however, only about 4 per cent of the normal annual consumption. During 1917 the production increased to about 12 per cent, and in 1918 to about 20 per cent, of the normal prewar consumption. The development has been carefully followed by the United States Geological Survey, which has published a detailed report of the condition of the industry during 1915, 1916, 1917, and 1918.

DOMESTIC PRODUCTION: 1915–1919.

SUMMARY.

The following account is a summary of the more detailed discussion of the industry contained in the reports of the United States Geological Survey: "Potash in 1916," by Hoyt S. Gale, "Potash in 1917," by Hoyt S. Gale and W. B. Hicks, and "Potash in 1918," by W. B. Hicks.

The increase in domestic production of potash and the growth of the industry during the period 1915–1919 is shown in the following table:

Potash produced and sold in the United States, 1915–1919.

Year.	Number of producers.		Production.		Sales.[1]		
	Total.	Exclusive of producers of wood-ash potash.	Crude potash.	Available content of potash (K_2O).	Crude potash.	Available content of potash (K_2O).	Value f. o. b. plant.
			Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	
1915[2]	5	5	4,374	1,090	4,374	1,090	$342,000
1916	70	25	35,739	9,720	35,739	9,720	4,242,730
1917	95	46	126,961	32,573	126,961	32,573	13,980,577
1918	128	77	207,686	54,803	140,343	38,580	15,839,618
1919[3]	77	45	119,736	32,418	.....	.....	.....

[1] Production and sales were practically the same from 1915 to 1917, and no distinction was made between them.

[2] Although no production was reported from wood ashes, it is probable that an appreciable quantity of potash was produced from that source in 1915.

[3] Supplied by the United States Potash Producers' Association.

DETAILED PRODUCTION BY YEARS.

1916.—The manufacturers of potash salts and potash products in the United States reported a production in 1916 of 35,739 short tons, having a mean content of about 27 per cent of potash (K_2O), and a total content of 9,720 short tons of potash (K_2O). This is almost exactly ten times the production reported for 1915.

Potash produced in the United States in 1916, classified according to source.

Source.	Available potash (K_2O).	
	Quantity (short tons).	Value at point of shipment.
Natural salts or brines	3,994	$1,937,600
Alunite and silicate rocks, including recoveries through furnace dust	1,850	715,000
Kelp	1,556	781,100
Wood ashes (potash pearlash)	[1] 412	270,000
Distillery waste (molasses)	1,845	500,900
Miscellaneous organic sources	63	38,130
Total	9,720	4,242,730

[1] The reported production from wood ashes amounted to 825 tons of salts of varying grades, containing about 50 per cent of potash.

1917.—The output of all potash materials produced and marketed in the United States in 1917, as reported by the manufacturers to the United States Geological Survey, was 126,961 short tons, which contained 32,573 short tons, or an average of 26 per cent, of pure potash (K_2O). This is more than three times the quantity produced in 1916.

Potash produced in the United States in 1917, classified according to source.

Source.	Number of producers.	Total production.	Available potash (K_2O).	Value at point of shipment.
Mineral resources:		*Short tons.*	*Short tons.*	
Natural brines	10	79,876	20,652	$3,261,873
Alunite (refined salts and crude and roasted alunite)	3	7,153	2,402	892,763
Dust from cement mills	8	13,582	1,621	700,523
Dust from blast furnaces	3	2,133	185	68,841
Organic sources:				
Kelp	10	11,306	3,572	2,114,315
Molasses residue from distilleries	4	8,589	2,846	1,130,907
Wood ashes	49	1,035	621	549,150
Evaporated Steffens water from sugar refineries	5	[1] 2,642	369	147,830
Evaporated wool washings and miscellaneous industrial wastes	3	645	305	113,875
Total	95	126,961	32,573	13,980,577

[1] Includes 1,333 tons of material produced but not sold in 1917.

1918.—In 1918 the manufacturers reported a production of potash materials amounting to 207,686 short tons, containing 54,803 short tons, or an average of 26.5 per cent of pure potash (K_2O). This is an increase of 68.5 per cent over the 1917 production of crude potash materials.

Potash produced and sold in the United States in 1918, classified according to source.

Source	Number of producers.	Production.			Sales.		
		Crude potash (short tons).	Available content of potash (K_2O).		Crude potash (short tons).	Available content of potash (short tons).	Value f. o. b. plant.
			Quantity (short tons).	Percentage of total.			
Mineral:							
Natural brines—							
Nebraska lakes	19	116,662	28,854	53	57,522	14,011	$5,098,023
Other sources	8	32,390	10,862	20	30,849	10,319	4,184,442
Alunite	4	6,180	2,621	5	6,180	2,621	1,276,774
Dust from cement mills	12	12,652	1,549	3	11,172	1,366	539,567
Dust from blast furnaces	6	3,155	310	.5	3,155	310	152,571
Silicate rocks							
Organic:							
Kelp	8	14,029	4,804	9	14,029	4,804	2,296,983
Molasses, distillery waste	8	11,792	3,467	6	11,792	3,467	1,335,516
Steffens water from beet-sugar refineries	8	8,795	1,374	2	3,650	742	267,309
Wood ashes	51	1,100	673	1	1,063	651	549,745
Wool washings and miscellaneous	4	931	289	.5	931	289	138,688
	128	207,686	54,803	100	140,343	38,580	15,839,618

1919.—Statistics of the United States Potash Producers' Association for 1919 show an output of 119,736 short tons of crude potash materials, representing a total of 32,418 short tons of actual potash (K_2O).[1] The average potash content was 27 per cent. This production is about equal to that for 1917 and a decrease of about 40 per cent from the production of 1918. This decrease, according to the association, was caused by a decreased demand in anticipation of heavy importations from Europe.

Potash produced in the United States in 1919, classified according to source.

Source.	Number of producers.	Crude potash.	Available content of potash.	
			Quantity.	Percentage of total.
Natural brines:		*Short tons.*	*Short tons.*	
Nebraska lakes	10	34,142	8,586	26.5
Other brines	6	49,313	13,722	42.3
Molasses, distillery waste	5	8,407	2,854	8.8
Steffens waste water	6	9,371	3,295	10.2
Alunite, silicates, kelp	4	4,179	2,057	6.3
Cement mill dust	11	12,285	1,236	3.8
Wood ashes	32	932	583	1.8
Blast furnace dust	3	1,107	85	.3
Total	77	119,736	32,418	100

[1] Official production statistics for 1919 have not been published by U. S. Geological Survey. (August 1, 1920.)

SOURCES OF AMERICAN POTASH.

NATURAL SALTS AND BRINES.

The greatest output has been secured from natural salt deposits and brines. The first large production came from various alkali lakes in the sand-hill region of western Nebraska. The brine of these lakes contains mixed sulphates, carbonates, and chlorides of sodium and potassium. The brine is pumped by pipe line to the railroad station, where the water is driven off by heat and the mixed salts recovered. During 1917 no attempt was made to purify or to refine the salts obtained; they were shipped in a crude form containing about 20 or 30 per cent of potash. These lakes have taken the lead in the production of potash in the United States, but they will probably be surpassed in the future by Searles Lake, Calif., and the Salduro Salt Marsh, Utah. It is estimated that the Nebraska lakes contain only about 10 years' supply based on the current rate of exploitation.

The Searles Lake deposit has been described in detail in a report published by the United States Geological Survey, from which the following brief sketch of its main features is taken:

Searles Lake is really not a lake at all; it is essentially a deposit of crystalline salts the surface of which is practically dry a considerable part of the year. This so-called lake occupies the bottom of a basin like valley which in prehistoric time contained a large and deep lake. After this ancient lake had dried, the salts that had been in solution in its waters were left on its bottom; so that now, when nearly all the surface water has disappeared, the most striking feature of the whole basin is the central level plain of white crystalline salts, which covers about 12 square miles. This salt plain is occasionally flooded by storm water, but during the dry season the water rapidly disappears. The salt itself is permeated by a thoroughly saturated brine, which maintains a practically constant level very close to the surface of the salt plain.

The many wells that have been bored into and through this deposit show that the salts average 60 to 75 feet in thickness and reach a maximum thickness of about 100 feet. The crystallized mass forms a great, somewhat irregular lens, which gradually becomes thinner toward the edges. These edges extend far out under the surface of the marginal mud zone, so that the deposit contains a much greater quantity of salts than could be determined prior to the extensive campaign of drilling that has now been carried out. The crystallized salts are evidently disposed in essentially horizontal layers and differ somewhat in composition at different depths in the deposit. The surface consists mainly of sodium chloride and has been called the "halite" zone. At a depth of about 15 feet there is commonly found a layer of an unusual and very distinctive mineral called hanksite, which is found also with many drillings taken from points below this depth. The salts associated with the hanksite contain more or less sulphate, although these also contain much sodium chloride. Toward the bottom of the deposit, layers of crystalline sodium carbonate in the form of the mineral "trona" are found, and at the bottom there is usually a layer or zone of "trona." The salts that are thus buried in an underground lake of brine are difficult to get out, and no active steps have been taken for their recovery in the solid form.

The brine that permeates the whole deposit is now considered its principal valuable constituent. It is a saturated solution of the crystallized salts, but it contains more potash and borax. It is to a certain extent a natural "bittern" or "mother liquor,"[1]

although the term bittern is not strictly applicable to a solution that contains no salts of magnesia. It is undoubtedly the liquor that remained after the crystal salts were formed by the natural concentration of the waters from the ancient lake that occupied this basin.

Analysis of salts in brine of Searles Lake, Calif.

Potassium chloride (KCl)	4.02
Borax ($Na_2B_4O_7$)	1.08
Sodium carbonate (Na_2CO_3)	4.26
Sodium sulphate (Na_2SO_4)	6.40
Sodium chloride (NaCl)	17.18
Total	32.94
Total determined	33.30

Probably no satisfactory means has been devised to determine the proportion of brine to crystalline salts in the deposit, but it is undoubtedly large. The salt crust itself is a porous mass, through which the brine flows so readily that the proportion of pore space, and consequently of brine, must be considerable. The original estimate of the Geological Survey that this pore space constitutes at least one-fourth of the volume of the deposit seems to be moderate. Continued pumping has shown only slight changes in the brine level, which quickly readjusts itself.

This deposit contains relatively more borax than the Nebraska deposit. It is being developed by two companies, but the production has been delayed by legal and technical complications. The production during 1916 was, therefore, small, but there can be little doubt that the output will eventually surpass the Nebraska lake district. The companies plan to separate the salts by a suitable refining process and to sell refined potassium chloride with other salts as by-products, especially borax, soda, sodium sulphate, and sodium chloride.

The Salduro, Utah, brine contains sodium, potassium, and magnesium chlorides, but very little sulphate and no carbonate or borate. This deposit resembles the German deposits more closely than any found in the United States. One great drawback in the operation of this plant is that all the water needed must be brought to the plant in tank cars. No production was secured during 1916, but the plant may become one of the largest producers in the country.

There are also three companies extracting potash from the water of the Great Salt Lake, which resembles ocean water in the proportion of the dissolved salts, but which is nearly six times as concentrated. A small output has also been secured from ocean water as a by-product of salt making. All of these plants are at a great distance from the South Atlantic States, the largest market for potash salts. None of them furnish a raw material as concentrated or as pure as the German potash deposits, and many of them are hampered by lack of water. The total amount of potash available in all of these saline deposits now known is probably only a fraction of 1 per cent of the amounts available in Germany.

During 1917, 79,876 short tons of crude potash salts containing 20,652 short tons of actual potash were produced from natural brines by 10 establishments. During 1918, there were 27 producers and the output was 148,952 short tons, containing 39,716 short tons of actual potash. In 1919 the number of producers fell off to 16 and their output was but 83,455 short tons of crude salts containing 22,308 short tons of actual potash.

ALUNITE.

Alunite is a mineral which is essentially a double potassium aluminum sulphate, which is insoluble in water. It is first heated to a red heat which decomposes the alunite and makes the potash soluble and the aluminum insoluble. The roasted mineral is leached with water and potassium sulphate recovered by evaporation. Commercial production has come almost entirely from mines near Marysvale, Utah. This deposit is not advantageously located, being about 6 miles from the nearest railroad and in a section of the country remote from any market. That potash can be produced from this source at a cost to compete with the German potash seems improbable unless processes can be devised which recover the aluminum oxide also in marketable form.

DUST FROM CEMENT MILLS.

Probably the most promising of all the attempts to recover potash is as a by-product of Portland cement mills. The flue dust from Portland cement mills has long been an annoyance. The first mill to install an effective device to collect the dust was the Riverside Portland Cement Co., of Riverside, Calif. The cement dust settled on oranges in its vicinity and made them unsalable. The owners of the orange groves brought damage suits against the Riverside Portland Cement Co. which compelled it either to abate the nuisance or close the mill.

A Cottrell electrostatic dust precipitator was installed which proved to be highly efficient. The dust collected was found to be rich enough in soluble potash salts to be valuable and salable as a fertilizer. Later the quality of the product was improved by leaching the dust with water and recovering a high-grade potash salt by crystallization. A nuisance was thus converted into a profitable by-product. It was then found that the yield of potash could be increased by adding a small proportion (up to 3 per cent) of feldspar to the cement raw material. t has also been found that the addition of a small amount of salt increases the liberation of potash from the cement. Fortunately the operative conditions most favorable for potash recovery are also most favorable for the production of cement of the best quality. The Security Cement & Lime Co., of Hagerstown, Md., was

the second company to install the Cottrell dust-collection system, and also secured a marked success, both technically and financially. This plant started operations toward the end of 1916. By the close of 1917 six additional plants were in operation, and by the end of 1918 the process was in operation at 12 cement mills. In 1918 the output was 12,652 tons of crude dust containing 1,549 tons of actual potash.

The permanency of this branch of the new potash industry seems reasonably assured. The operating costs are low. It seems improbable that potash prices will go so low in the future that the value of the product will fall below operating expenses.

The demonstrated technical success of the process is likely to result in legal pressure on all cement mills to compel the installation of the necessary equipment to abate the dust nuisance to the surrounding country. Under these circumstances the potash will be collected and sold for whatever it will bring, regardless of whether the returns are greater or less than the operating cost. It has been estimated by the Department of Agriculture that if this equipment were installed at all of the cement mills in the United States, the yield would be 75,000 tons of actual potash (K_2O), or nearly one-third of the normal prewar consumption.

DUST FROM BLAST FURNACES.

There is a possibility that potash may be secured as a by-product in the pig-iron blast furnace. The raw materials fed into the blast furnace contain a minute percentage of potash, but the aggregate amount is large. Under the usual process, 80 per cent of this potash is volatilized in the furnace and passes out with the gases from the top of the furnace. The gases are then washed with water to remove most of the dust and are then burned in hot blast stoves or under boilers. Most of the potash is irretrievably lost in these wash waters, which are too dilute to permit the profitable recovery of the potash. However, a part escapes the washers and gradually accumulates in the stoves and boilers from which it must be cleaned out periodically. This dust contains sufficient potash to make it salable as fertilizer. During 1917 three companies only were selling this dust. The amount of actual potash (K_2O) contained in the dust sold was only 185 tons.

Experiments to develop a dry method of collecting the dust have been made with considerable promise of success. A systematic study of iron ores and fluxes has been made by the Department of Agriculture, and actual experiments have been made by the Bethlehem Steel Co. and United States Steel Corporation. This work indicates that there is not sufficient potash in the Lake Superior iron ores to make its recovery profitable, but that the southern ores, Cuban ores, and ferromanganese ores contain sufficient potash to make its commercial recovery a promising prospect.

KELP.

A great deal of attention has been given to the production of potash from kelp. The output of the nine companies which reported production during 1916 was 1,556 tons of actual potash (K_2O). During 1917 there were 10 companies in operation with an output of 11,306 short tons of crude material containing 3,572 tons of actual potash (K_2O). During 1918 the number of producers dropped to eight, but the output increased to 14,029 tons of crude salts containing 4,804 tons of actual potash. Kelp is a giant seaweed that grows along the Pacific coast of the United States. It has an exceptional power to absorb potash from sea water. The air-dried kelp contains from 10 to 15 per cent of actual potash, chiefly in the form of the muriate, together with a little more than 1 per cent of ammonia and a little less than 1 per cent of phosphoric acid, both of which have fertilizer value.

An estimate prepared by F. K. Cameron, of the Department of Agriculture, in 1915, was to the effect that the annual growth of kelp contains more than five times the prewar consumption of potash in the United States. Recent experience of the industry, however, indicates that these estimates are many times too great and that much of the kelp can not be commercially harvested.

When the industry first started there was no control over the harvesting of the kelp, but anyone was free to cut the kelp when and where he pleased. As the industry developed this plan resulted in difficulties. There proved to be insufficient amounts conveniently accessible to the factories, and the consequent rivalry resulted in excessive and premature cutting.

The California Legislature passed a bill putting control of the kelp beds in the hands of the California Fish and Game Commission and imposing a tax on the kelp harvested. During the winter of 1916–17 a portion of the beds was seriously damaged by a disease.

The purely technical problems of harvesting the kelp have been solved by the invention of a submarine harvester mounted on a seagoing barge, which cuts the kelp about 6 feet under the surface and loads it into the barge. The cost is said to be about $1 per ton of wet kelp.

There are three distinct methods of marketing the product. The simplest method is to dry the kelp and then grind it to a powder, which may be sold as fertilizer. This method utilizes the ammonia and phosphoric acid for fertilizers also; it has the great drawback, however, that over 80 per cent of the dried product is valueless and the cost of shipment, therefore, probably will prevent its distribution except in local markets.

The second method is to heat the dried kelp to a low red heat, thereby charring it and driving off much of the useless organic matter.

The product is a "kelp char" containing about 30 per cent of potash. In the future, arrangements will probably be made to collect volatile by-products, but little has been accomplished along these lines yet. The "kelp char" may be sold for fertilizers as such or it may be leached with water to extract the potash salts. A high-grade potash salt may be recovered by crystallization. The process is used in several plants operated by private firms and also in a plant built and operated by the Department of Agriculture. It is planned to carry out extensive experimental work in this Government plant for the purpose of developing the best methods of treatment and for the recovery of all possible by-products. The most important of these by-products probably will be iodine, a high-priced material not produced in the United States.

A third process is to decompose the wet kelp by fermentation. By this method the vegetable matter is largely converted into acetic acid with small amounts of butyric and propionic acids. This process has been adopted primarily to secure the acetic acid, for which there was a great demand in the manufacture of explosives. After fermentation, the liquid is filtered and the salts are separated by evaporation and crystallization. The potash salts are really a by-product rather than the main product of this reaction. The potash is marketed in the form of a high-grade muriate of about 97 per cent purity. Other by-products include iodine, ethyl butyrate, and ethyl propionate. The process was devised and the plant built by the Hercules Powder Co. as a result of an offer by the British Government of a contract for the explosive cordite at a high price, but with the provision that the acetone needed to make the explosive should not be obtained from any known source, but should be obtained by a new plant and new process. This plant was shut down soon after the signing of the armistice.

It is not probable that potash can be commercially recovered from kelp when normal conditions are restored, except, perhaps, for purely local use. In fact, several of the plants shut down within a few months after the signing of the armistice before any German or Alsatian potash reached the American markets.

MOLASSES DISTILLERY AND BEET-SUGAR WASTES.

Potash has been obtained as a by-product from distilleries utilizing molasses as a raw material. The potash is contained in the juice of the sugar cane and is concentrated in the molasses when the sugar is crystallized. The molasses is then fermented and the alcohol produced distilled. The potash remains in the residue in the stills. In the past the residue has usually been discarded. The high prices which have recently prevailed have made it possible to recover the potash profitably by evaporation and crystallization. It is not to

be expected that this operation will be continued when normal prices again prevail. During 1918 eight firms produced 3,467 short-tons of actual potash from this source.

Molasses contains about 4 per cent of potash. The Geological Survey estimated that if all the potash were recovered from the molasses fermented and distilled in the United States about 30,000 tons of potash would be obtained.

A small production has been secured as a by-product of the beet-sugar industry, the potash being recovered from waste liquor from which the sugar has been removed as completely as possible. In 1918, eight firms produced 8,795 tons of crude material containing 1,374 tons of actual potash (K_2O).

It is estimated that the sugar beets grown annually in the United States contain 18,000 tons of potash. It is obvious that potash as a by-product of the sugar industry offers no hope of a real solution of potash shortage. Even if the recovery of the potash were complete, all of it would have to go back to the fields from which it was taken in order to maintain their fertility, and no surplus would be left for other crops.

WOOD ASHES.

Wood ashes at one time furnished the only commercial source of potash salts, and this source has been revived on a small scale. The potash obtained from this source is a by-product of lumber mills or woodworking establishments using hardwoods. The sawdust and scrap is usually burned as fuel. The ashes are rich in potash. The wood ashes may be used directly as fertilizer or a more concentrated salt may be made by mixing with lime and leaching with water, followed by evaporation. The product is a mixed carbonate and hydroxide which is used for chemical purposes. There were 49 plants which produced potash from these sources in 1917, the output of which was 1,035 tons of crude material, containing 621 tons of actual potash. In 1918, 51 firms produced 1,100 tons of crude potash, containing 673 tons of actual potash. The output per plant is small. The industry is centered around the hardwood lumber districts of Michigan and Wisconsin. There is no prospect that the output will become large enough to be comparable with the normal consumption of potash. A small output of 92 tons of actual potash was secured by three firms from other industrial wastes, chiefly wool scourings.

DEVELOPMENT IN OTHER COUNTRIES.

Probably the most important new development in other countries has been the discovery that some of the Chilean sodium nitrate deposits contain appreciable amounts of potassium nitrate. Methods

suitable for the separation of the sodium and potassium nitrates have been devised and put into operation both in Chile and in the United States.

A process for the separation of the sodium and potassium nitrates has been put into operation by the Du Pont Co. and has reached an output of over 1,000 tons of actual potash per year in the form of the nitrate. If this process was used by all nitrate plants it is estimated that over 100,000 tons of potash would be recovered.

Japan has also become an exporter of potash, especially the muriate and chlorate. Although little definite information in regard to the Japanese industry is available, it is believed that kelp is the primary source of most of the potash.

There have been various reports of the discovery of deposits of potash salts resembling the German deposits in Spain and Abyssinia and of alunite deposits in Italy and Australia, but there has been very little commercial development from these sources. A beginning has been made in the recovery of potash from cement mills and blast furnaces in England, Canada, Spain, and Japan.

INDIVIDUAL SALTS AND POTASH MATERIALS.

POTASSIUM CARBONATE AND BICARBONATE.

Uses.—The carbonate is used in the manufacture of soft soaps, of Bohemian and flint glass, in dyeing, and in wool washing. The bicarbonate is used in the preparation of the pure carbonate.

Manufacture.—Potassium carbonate was formerly obtained almost entirely from wood ashes, but now very little is produced from this means, except in Russia and to a small extent in the United States.

Much is now manufactured from the Stassfurt salts by the Leblanc process. By this process the potash salts are mixed with powdered coal and limestone and heated in a furnace which converts them to carbonate. This carbonate is purified by solution and evaporation.

Potassium carbonate is also recovered to some extent from the distillery waste of molasses obtained from beet-sugar manufacture.

Domestic production.—During 1918, 229,287 pounds of refined potassium carbonate and bicarbonate were produced. Of this, 201,574 pounds were marketed for $104,432. In addition, 1,827,000 pounds of crude carbonate from wood ashes were produced and 1,753,000 pounds, valued at $331,000, were sold.

Imports.—Prior to the war, imports of carbonate of potash, including crude or black salts, were about 20,000,000 pounds per year and came chiefly from Germany. The import decreased during the war to a minimum of about 2,000,000 pounds in 1916. In 1918 the imports had increased to over 14,000,000 pounds and over 90 per cent of this quantity came from Russia.

Imports for consumption.

POTASH, BICARBONATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	25 per cent	342,856	$16,915	$4,228	$0.049	25.00
1910	do	334,300	16,633	4,158	.049	25.00
1911	do	325,016	16,428	4,107	.051	25.00
1912	do	275,204	13,155	3,288	.048	25.00
1913	do	311,645	14,295	3,573	.046	25.00
1914	do	96,991	4,474	1,118	.046	25.00
1914	½ cent per pound	381,862	18,293	1,909	.048	10.44
1915	do	383,534	20,341	1,917	.053	9.43
1916	do	2,062	614	10	.298	1.66
1917	do	10,053	5,271	50	.524	.95
1918	do	171,528	84,381	857	.492	1.01
1919	do	87,946	25,119	440	.285	1.75

POTASH, CRUDE OR BLACK SALTS.

1909	Free	9,628,906	$324,540		$0.033	
1910	do	8,407,373	263,643		.031	
1914	do	2,599,883	52,454		.020	
1915	do	4,076,783	83,502		.020	
1916	do	1,540,149	53,752		.035	
1917	do	2,819,235	233,111		.083	
1918	do	727,588	112,235		.154	
1919	do	268,441	12,814		.047	

POTASH, CARBONATE OF, CRUDE.

1911	Free	10,680,341	$327,400		$0.031	
1912	do	6,747,150	211,602		.031	
1913	do	10,063,912	295,066		.029	
1914	do	9,046,302	240,451		.027	
1915	do	8,620,504	291,341		.034	
1916	do	444,241	27,689		.062	
1917	do	1,069,408	185,910		.174	
1918	do	13,183,741	2,928,289		.222	
1919	do	1,092,792	373,745		.342	

POTASH, CARBONATE OF, REFINED.

1909	Free	11,009,479	$379,392		$0.034	
1910	do	9,036,267	303,917		.034	
1911	do	11,143,144	396,728		.036	
1912	do	11,627,209	383,958		.033	
1913	do	14,035,111	412,587		.029	
1914	do	10,421,005	368,958		.035	
1915	do	2,377,940	92,959		.039	
1916	do	174,587	38,604		.221	
1917	do	202,385	53,170		.262	
1918	do	445,282	124,019		.278	
1919	do	130,040	40,980		.315	

Imports by countries.

POTASH, CARBONATE OF, INCLUDING CRUDE OR BLACK SALTS.

[Free.]

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	12,819,188	$462,370	11,186,415	$384,230	15,908,275	$534,865
France	2,320,931	66,063	2,384,244	63,686	3,468,812	88,343
Belgium	3,279,776	84,878	2,259,339	60,530	1,800,112	45,887
Netherlands			32,704	1,076	53,672	1,861
All other	2,218,528	90,621	1,570,700	57,923	1,569,481	53,173
Total	20,638,423	703,932	17,433,402	567,445	22,800,352	724,129

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	13,139,550	$442,580	16,092,080	$515,567	12,876,305	$419,596
France	1,332,118	38,734	1,102,786	28,545	1,415,966	30,898
Belgium	1,781,030	46,608	2,252,247	56,598	2,517,034	54,876
Netherlands	11,427	232				
All other	1,611,682	51,295	2,792,336	83,035	3,794,288	109,556
Total	17,875,807	579,449	22,239,449	683,745	20,603,593	614,926

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	8,788,653	$295,719	2,305	$121		
France	85,502	2,949	358,400	3,281		
Belgium	259,948	6,351				
Netherlands	58,692	3,028	584,512	17,535	1,247,140	$76,877
All other	3,841,976	113,232	1,173,070	98,812	3,252,400	395,218
Total	13,034,771	421,279	2,118,287	119,779	4,499,540	472,095

Imported from—	1918 [1]		1919	
	Pounds.	Value.	Pounds.	Value.
Germany				
France				
Belgium				
Netherlands				
All other				
Total	14,468,211	$3,166,043	1,491,273	$427,539

[1] Over 10,000,000 pounds of the total was imported from Russia.

POTASSIUM CHLORATE.

Description and uses.—Potassium chlorate is a white crystalline substance which is not very soluble in cold water. It is a strong oxidizer and when mixed with sulphur and charcoal forms an explosive powder.

It is used where an oxidizer is required, as in the manufacture of matches, fireworks, percussion caps and certain explosive powders. It is also used as an oxidizer in dyeing aniline black. The purified chlorate is used in medicine.

Manufacture.—An electrolytic process is generally used in the manufacture of potassium chlorate. A solution of potassium chloride is subjected to the action of a direct electric current in an electrolytic cell so that the chlorine and caustic potash which are formed come in contact with each other and combine to form potassium hypochlorite. The reaction is carried out at a temperature sufficiently high to cause the decomposition of the hypochlorite into potassium chlorate. The solution of potassium chlorate is withdrawn from the apparatus and the potassium chlorate is crystallized from the solution.

Domestic production.—In 1914 the production of potassium and sodium chlorates combined was 8,304 short tons, valued at $1,131,316. During 1918, 4,877 short tons of potassium chlorate valued at $2,837,892 were produced by the three manufacturers.

Imports.—The imports of potassium chlorate have been rather sporadic. The largest importation prior to the war was in 1913, when over 1,200,000 pounds were imported. The imports during the war have been considerably less than this quantity, until in 1918 when the import was about 1,000,000 pounds. Japan has been very active in the production of potassium chlorate during the war and it is likely that this import originated in Japan.

Imports for consumption.

POTASH, CHLORATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	2½ cents per pound	20,801	$1,655	$520	$0.079	31.42
1910	2 cents per pound	413,885	26,608	8,277	.064	31.11
1911	do	25,069	2,096	501	.083	23.92
1912	do	42,131	3,444	842	.082	24.47
1913	do	1,235,732	66,609	24,714	.054	37.10
1914	do	7,380	704	147	.095	20.97
1914	½ cent per pound	32,939	2,704	164	.082	6.09
1915	do	27,419	4,614	137	.168	2.97
1917	do	437,339	194,008	2,186	.444	1.13
1918	do	1,006,320	357,520	5,031	.355	1.41
1919	do	315,565	113,498	1,578	.359	1.39

Exports.—Exports of potassium chlorate are not shown in Commerce and Navigation prior to 1918 when there was exported 1,564,662 pounds valued at $681,128. Australia and British Africa were the chief consuming countries.

POTASSIUM CHLORIDE (MURIATE OF POTASH).

Description and uses.—Potassium chloride, known commercially as muriate of potash, occurs as the mineral sylvite, and also in carnallite, a mixed chloride of potassium and magnesium, in the Stassfurt and other salt deposits of Europe. When pure it is a white crystalline solid readily soluble in water.

The chief use of the crude salt is as a fertilizer. It is also used as the crude material for the preparation of caustic potash and chlorate of potash by the electrolytic process.

Manufacture.—Germany manufactures large quantities of potassium chloride from the Stassfurt carnallite. The method of manufacture depends upon the fact that carnallite is decomposed by water which separates crystals of potassium chloride and causes the magnesium chloride to pass into solution. On heating, much more potassium chloride passes into solution, which, on cooling, separates almost entirely free from magnesium chloride. In actual practice the carnallite is dissolved in hot water until saturated, when it is filtered from any insoluble matter and then allowed to cool. On cooling, nearly pure potassium chloride separates, provided the proportion of magnesium chloride in solution does not exceed three times the potassium chloride. The liquor may be used for dissolving fresh portions of carnallite. The potassium chloride may be purified by washing with cold water or by dissolving and recrystallizing.

Some potassium chloride is also obtained from kelp and some from the liquors left from the manufacture of salt from sea water.

Domestic production.—Potassium chloride has been produced in this country during the war. In 1918 the production of muriate of potash was 31,486 tons of crude salt, containing 13,184 tons of actual potash (K_2O). In addition there was produced 6,589 tons of a low grade chloride of potash, containing 901 tons of actual potash (K_2O).

Imports.—Prior to 1916 the United States imported most of the potassium chloride it consumed from Germany, the amount in 1914 being 237,886 tons, with a value of $7,915,523. Since then the total imports have fallen off greatly, the records showing only 606 tons in 1917, mostly from Scotland and Japan, and 723 tons in 1918. There have been no imports from Germany since 1916, when only 8 tons were imported from that country.

Imports by countries.

POTASH, MURIATE OF.

[Free.]

Imported from—	1909		1910		1911	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	131,802	$4,724,505	174,589	$5,635,011	190,354	$6,343,719
Netherlands	607	22,527				
Belgium	123	4,220			1,464	71,479
All others	202	7,645	145	5,630	689	34,378
Total	132,734	4,758,897	174,734	5,640,641	192,507	6,449,576

Imported from—	1912		1913		1914	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	215,627	$7,225,779	201,200	$6,781,181	236,218	$7,854,895
Netherlands	255	7,568			434	12,858
Belgium	75	2,371	20	865	94	3,529
All others				10	1,140	44,241
Total	215,957	7,235,718	201,220	6,782,056	237,886	7,915,523

Imported from—	1915		1916		1917	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	90,443	$3,112,559	8	$800		
Netherlands	10,163	434,282				
Belgium						
All others	2,126	119,277	2,122	460,631		
Total	102,732	3,666,118	2,130	461,431	606	$174,806

Imported from—	1918		1919	
	Tons.	Value.	Tons.	Value.
Germany				
Netherlands				
Belgium				
All others				
Total	723	$195,154	1,677	$201,307

Imports for consumption.

POTASH, MURIATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Tons.		
1909	Free	132,740	$4,758,906	$35.85
1910	do	174,935	5,640,541	32.24
1911	do	191,324	6,449,575	33.71
1912	do	216,101	7,235,728	33.48
1913	do	199,854	6,737,757	33.71
1914	do	234,855	7,925,781	33.75
1915	do	102,882	3,660,353	35.58
1916	do	2,126	460,888	216.78
1917	do	606	174,806	288.45
1918	do	596	156,979	263.38
1919	do	1,677	201,307	120.04

POTASSIUM CHROMATE AND DICHROMATE.

Description.—These are both salts of potash and chromic acid and have much the same uses. Both crystallize well, but the dichromate being much less soluble in cold water crystallizes better and is the one usually prepared. The chromate may be converted to the dichromate by treatment with acids and the dichromate to the chromate by treatment with an alkali. Potassium chromate is yellow and potassium dichromate is orange red.

Uses.—Potassium dichromate is used to a much greater extent than the chromate of potash, owing to its greater richness in chromic acid and the fact that it is more easily crystallized and purified. It is a strong oxidizing agent. The chief uses of dichromate of potash are in the chrome tanning of leather, textile dyeing and printing, manufacture of chrome pigments and colors, pickling of brass, and the electroengraving of copper plates. It is also used in bleaching oils and fats, for other oxidation purposes, and as a chemical reagent. Wherever possible the cheaper sodium salt is now being used instead of the potassium salt.

Manufacture.—Potassium chromate and bichromate are prepared from chrome iron ore or chromite, the larger portion of which is imported. The ore is pulverized and mixed with lime and potassium carbonate. This mixture is then heated to bright redness in a strong current of air. The fused mass is then lixiviated with water forming a solution of calcium and potassium chromates. Additional potash, usually potassium sulphate, is added to the solution to convert the calcium chromate into potassium chromate. The clear solution of potassium chromate is then drawn off and treated with sulphuric acid, thus producing potassium dichromate which is crystallized from the solution.

Domestic production.—During 1918 there were four producers of potassium chromate and bichromate and their output was reported to be 681,346 pounds. Sales during that year were reported to be 1,003,598 pounds valued at $407,793.

Imports.—The imports since 1910, have not been more than 40,000 pounds and have been entirely negligible since 1915.

Imports for consumption.

POTASH, CHROMATE AND DICHROMATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	3 cents per pound	171,541	$12,330.00	$5,146.00	$0.072	41.74
1910	2½ cents per pound	877,151	43,037.00	19,735.00	.049	45.86
1911	do	22,880	1,699.00	514.00	.076	30.30
1912	do	24,094	2,273.00	542.00	.094	23.85
1913	do	27,671	2,601.00	622.00	.108	23.94
1914	1 cent per pound	34,860	2,822.00	348.00	.081	12.35
1915	do	40,227	3,317.00	402.00	.082	12.12
1916	do	2,291	391.00	22.00	.171	5.86
1917	do	2,404	962.00	24.00	.400	2.50
1918	do	20	8.00	.20	.400	2.50
1919	do					

POTASSIUM CYANIDE.

Description.—Potassium cyanide is a white crystalline solid. It is very soluble in water and is extremely poisonous. At present sodium cyanide, because it is much cheaper and contains a larger per cent of cyanide, has practically driven potassium cyanide off the market. Much so-called "potassium cyanide" is actually sodium cyanide.

Uses.—Its principal use is for the extraction of gold and silver from their ores. Potassium cyanide is also used extensively for fumigating, especially in the culture of citrus fruits. Other uses are as a solvent for electroplating baths and as a flux in assaying and metallurgy.

Manufacture.—Potassium cyanide is made by fusing potassium ferrocyanide with potassium carbonate and carbon and the product purified by dissolving in alcohol.

It may be made from cyanamid by fusing with potassium chloride and carbon when the cyanamid and potassium chloride combine to form the cyanide. The crude product obtained in this way is pure enough for many purposes.

Domestic production.—Prior to the war domestic production did not supply the demand, considerable amounts being imported. The war has, to a large extent, cut off the imports, and the demand has been met by an increased production of sodium cyanide instead of potassium cyanide.

Imports.—Prior to 1913 the import of potassium cyanide was more than 2,000,000 pounds per year, over 90 per cent of which came from Germany.

Imports for consumption.

POTASH, CYANIDE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	12½ per cent	2,752,983	$386,354	$48,294	$0.140	12.50
1910	do	2,422,667	328,146	41,018	.135	12.50
1911	do	2,325,289	326,972	40,871	.141	12.50
1912	do	2,095,541	312,777	39,097	.149	12.50
1913	do	950,890	137,535	17,191	.145	12.50
1914	do	231,312	35,648	4,456	.154	12.50
1914	Free	1,005,487	147,611		.147	
1915	do	747,627	143,331		.192	
1916	do	43,705	9,311		.213	
1917	do	70,147	49,513		.706	
1918	do	13,455	3,150		.234	
1919	do	444,581	32,161		.072	

Imports by countries.

POTASH, CYANIDE OF.[1]

[Dutiable.]

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	2,291,719	$343,749	777,441	$117,101	167,830	$25,437
England	284,979	41,973	231,454	29,495	49,616	7,806
Belgium	145,432	21,210				
All other	35,049	3,846				
Total	2,757,179	410,778	1,008,895	146,596	217,446	33,243

[Free.]

Imported from—	1914		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	460,042	$59,360	179,972	$28,710	25	$35
England	130,561	20,470	55,924	9,519	10,080	1,801
Austria-Hungary			709,797	104,575		
All other	672	126	830,024	20,924	33,600	7,475
Total	591,275	79,956	1,775,717	163,728	43,705	9,311

Imported from—	1917		1918		1919[2]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany						
England			10,988	$2,212		
Austria-Hungary						
Spain			130,770	45,173		
Japan	72,772	$51,675	2,177	664		
All other	31,807	24,533	290	274		
Total	104,579	76,208	144,225	48,323	431,339	$24,170

[1] 1909–1910 included in all other chemicals. 1911 included in all other salts of potash.
[2] Entirely from Canada.

POTASSIUM FERRICYANIDE (RED PRUSSIATE OF POTASH).

Description.—Potassium ferricyanide is known commercially as red prussiate of potash. It crystallizes from water in large red crystals without water of crystallization. It is poisonous and very soluble in water.

Uses.—Being a powerful oxidizer it is used in calico printing. Other uses are in the manufacture of blue-print paper and for the production of pigments, such as Turnbull's blue.

Manufacture.—The usual method of manufacture is to treat the ferrocyanide with chlorine. This is preferably done in solution.

Domestic production.—Figures for the domestic production are not available but it probably has increased considerably since 1915, as the imports have shown a very great decrease since then.

Imports.—In 1914 the imports were 89,976 pounds, nearly all of which came from Germany and Austria-Hungary. In 1915 the imports were only slightly less but in 1916 dropped to 2,040 pounds. Since then the imports have increased somewhat and in 1919 amounted to 13,992 pounds.

Imports for consumption.

POTASH, PRUSSIATE OF, RED.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	8 cents per pound	77,255	$13,522	$6,180	$0.175	45.71
1910	do	65,777	12,460	5,262	.189	42.23
1911	do	55,082	10,230	4,406	.186	43.07
1912	do	71,612	11,264	5,728	.158	50.86
1913	do	65,316	11,302	5,225	.173	46.23
1914	do	4,873	835	389	.172	46.69
1914	2 cents per pound	85,103	14,490	1,702	.170	11.75
1915	do	83,574	14,922	1,671	.178	11.20
1916	do	2,040	3,182	40	1.56	1.28
1917	do	4,523	10,425	90	2.30	.87
1918	do	9,924	18,495	198	1.86	1.07
1919	do	13,902	25,497	280	1.82	1.09

POTASSIUM FERROCYANIDE (YELLOW PRUSSIATE OF POTASH).

Description.—Potassium ferrocyanide, known as yellow prussiate of potash, crystallizes from water in large yellow crystals containing water of crystallization. When heated or exposed to dry air, the crystals lose their water and become a white powder. Potassium ferrocyanide is readily soluble in water and is not poisonous.

Uses.—Potassium ferrocyanide is used for the preparation of Prussian blue, in calico printing, for dyeing silk, for casehardening of iron, and for making potassium cyanide and ferricyanide. Small amounts are used in the manufacture of some explosives and as a reagent in analytical chemistry. Within the last few years sodium ferrocyanide has replaced potassium ferrocyanide for most purposes because it is much cheaper and in many cases is just as efficient.

Manufacture.—Formerly the method for manufacturing potassium ferrocyanide was to fuse nitrogenous organic matter with potassium carbonate and iron borings. The organic matter used was hides, hoofs, hair, blood, etc. After fusion, the remaining mass was treated with water near the boiling point for some hours, the solution drawn off, and the ferrocyanide allowed to crystallize.

At present potassium ferrocyanide is produced almost entirely from the spent oxide which is obtained during the purification of coal gas. This is first treated with water to dissolve out ammonia and soluble salts, then dried, the sulphur extracted with carbon bisulphide, and the residue mixed with lime. This is then heated

with steam and forms calcium ferrocyanide, and on treating this with potassium chloride a double calcium potassium ferrocyanide is formed. When this is treated with potassium carbonate, calcium carbonate separates and potassium ferrocyanide remains in solution.

Domestic production.—In 1909 the United States produced 3,510,208 pounds of potassium ferrocyanide and in 1914, 3,204,684, which probably represented a little less than half of the total consumption. In 1918 there were but three producers and their output was 457,267 pounds.

Imports.—The imports for 1914 amounted to 3,508,229 pounds, more than 50 per cent of which came from Germany and about 27 per cent from England. In 1915 the imports were 2,316,736 pounds but dropped the next year to 44,156 pounds. In 1918 the imports were 134,638 pounds.

Imports for consumption.

POTASH, PRUSSIATE OF, YELLOW.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	4 cents per pound	1,754,377	$178,744	$70,175	$0.102	39.26
1910	do	2,330,871	229,907	93,234	.097	40.55
1911	do	1,777,313	180,584	71,092	.101	39.37
1912	do	2,072,761	203,295	82,910	.098	40.78
1913	do	2,812,408	309,302	112,496	.110	36.37
1914	do	521,244	58,455	20,849	.112	35.67
1914	1½ cents per pound	2,986,984	331,566	37,337	.111	11.26
1915	do	2,316,736	255,711	28,959	.110	11.32
1916	do	44,156	31,551	551	.717	1.74
1917	do	41,128	32,251	514	.784	1.59
1918	do	134,638	111,096	1,683	.825	1.51
1919	do	58,003	45,869	725	.790	1.58

POTASSIUM HYDRATE.

Description.—This substance, also known as caustic potash, or potassium hydroxide, is a white solid substance. It absorbs water and carbon dioxide readily from the air and is very easily soluble in water, giving a strongly caustic solution.

Uses.—It is used in the manufacture of soft soaps, in the preparation of oxalic acid, in the manufacture of some dyes, and in preparing caustic lyes, and as a chemical reagent. Owing to the great advance in price of potash salts it is being replaced wherever possible by sodium hydroxide.

Manufacture.—The usual method of manufacture is by the electrolysis of a solution of potassium chloride.

Domestic production.—There were 14 producers of potassium hydroxide during 1918 and their output was 1,984,847 pounds, of which 1,594,580 pounds were sold for $856,148.

Imports.—Since 1913 the imports have declined so that in 1917 the total imports amounted to only 68,095 pounds as compared to 8,896,805 pounds in 1913. Most of the imports before 1916 were from Germany.

Imports by countries.

POTASH, HYDRATE OF, OR CAUSTIC—NOT IN STICKS OR ROLLS.

[Free.]

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	4,611,729	$204,720	6,183,411	$256,602	5,557,278	$244,936
Belgium	599,647	21,091	516,594	18,189	778,157	22,314
Austria-Hungary	499,012	18,966	608,677	23,184	341,214	12,044
United Kingdom	335,937	16,789	708,433	34,259	463,200	22,551
All others	986,334	33,143	776,276	25,699	284,297	8,152
Total	7,032,659	294,709	8,793,391	357,933	7,424,146	309,997

Imported from—	1912		1913		1914 [1]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	7,024,946	$280,895	7,499,356	$289,351	1,682,631	$66,313
Belgium	541,490	17,499	416,232	15,169	5,726	190
Austria-Hungary	157,022	6,330	704,754	28,273	260,764	8,899
United Kingdom	343,502	16,049	123,278	6,238	33,605	2,083
All others	353,102	9,839	153,185	5,370	400	54
Total	8,420,052	330,612	8,896,805	344,401	1,983,126	77,539

POTASH, HYDRATE OF, CONTAINING NOT MORE THAN 15 PER CENT CAUSTIC SODA.

[Free.]

Imported from—	1914 [2]		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	5,867,065	$219,936	4,444,128	$179,599	4,500	$700
Belgium	63,706	2,246	47,938	1,485	.....	.....
Austria-Hungary	291,040	13,285	.....	.....	.....	.....
United Kingdom	48,173	3,005	52,272	5,918	.....	.....
All others	197,292	10,657	472,953	38,547	39,470	8,732
Total	6,467,276	249,129	5,017,291	225,549	43,970	9,432

Imported from—	1917		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	.....	.....	.....	.....	.....	.....
Belgium	.....	.....	.....	.....	.....	.....
Austria-Hungary	.....	.....	.....	.....	.....	.....
United Kingdom	11,355	$5,905	.....	.....	.....	.....
All others	[3] 56,740	24,508	.....	.....	.....	.....
Total	68,095	30,413	11,732	$4,398	466,620	$124,563

[1] Figures cover period July 1 to Oct. 3, 1913, inclusive.
[2] Figures cover period Oct. 4, 1913, to June 30, 1914.
[3] Chiefly from Sweden.

Imports for consumption.

POTASH, HYDRATE OF, OR CAUSTIC, NOT INCLUDING REFINED, IN STICKS OR ROLLS.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	7,041,657	$294,709		$0.042	
1910	do	8,785,491	358,855		.041	
1911	do	7,426,402	309,965		.042	
1912	do	8,422,007	330,684		.039	
1913	do	8,994,449	348,500		.039	
1914	do	1,986,326	77,620		.039	

POTASH, HYDRATE OF, OR CAUSTIC, REFINED, IN STICKS OR ROLLS.

1909	1 cent per pound	127,611	$9,289	$1,276	$0.073	13.74
1910	do	141,430	11,094	1,414	.079	12.75
1911	do	82,854	9,254	828	.112	8.95
1912	do	77,184	8,096	771	.105	9.53
1913	do	112,821	11,919	1,128	.106	9.47
	D. R. U. S.	1	1			
1914	1 cent per pound	18,751	1,977	187	.105	9.48

POTASH, HYDRATE OF, NOT CONTAINING MORE THAN 15 PER CENT CAUSTIC SODA.

1914	Free	6,579,125	$249,080		$0.038	
1915	do	4,993,471	225,002		.045	
1916	do	39,770	9,222		.232	
1917	do	75,720	33,648		.450	
1918	do	11,732	4,398		.375	
1919	do	466,620	124,563		.0267	

POTASSIUM IODIDE AND IODATE.

Description and uses.—Potassium iodate is of very little commercial importance. Potassium iodide is an important medicinal and chemical reagent. Sodium iodide is replacing potassium salt to a great extent, because it is much cheaper and for most purposes it is equally suitable.

Domestic production.—During 1918 eight manufacturers reported a production of 521,678 pounds of potassium iodide. Sales during the year amounted to 481,301 pounds, valued at $1,587,656.

Imports.—The imports of potassium iodide and iodate were small and practically negligible prior to the war. Since 1916 the import has increased until in 1918 there was imported 65,992 pounds. Japan has exported considerable quantities of potassium iodide during the war, and it is likely that these imports were from that country.

Imports for consumption.

POTASH, HYDRIODATE, IODIDE, AND IODATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	25 cents per pound	242	$489	$60	$2.02	12.35
1910	do	142	275	35	1.93	12.91
1911	do	272	519	68	1.91	13.10
1912	do	238	451	59	1.89	13.19
1913	do	120	239	30	1.99	12.55

POTASSIUM IODIDE.

1914	15 cents per pound	162	$491	$24	$3.03	4.96
1915	do	4	13	1	3.25	4.62
1916	do	309	1,032	46	3.34	4.49
1917	do	24,357	58,752	3,653	2.41	6.22
1918	do	65,992	133,611	9,899	2.02	7.41
1919	do	25,963	74,834	2,894	2.88	5.20

POTASSIUM NITRATE.

Description.—Potassium nitrate, or saltpeter, is the potassium salt of nitric acid. It is a white crystalline substance which is easily soluble in water.

Uses.—Potassium nitrate is one of the ingredients of ordinary gunpowder and of some other explosives and fireworks. It is also used in curing meats and as a reagent in assaying.

Manufacture.—Formerly potassium nitrate was obtained almost entirely from niter earths, which occur mostly in India. Now much of it is produced by the double decomposition of sodium nitrate and potassium chloride. Before the war large quantities were made in this way in Germany from the potassium chloride of Stassfurt and sodium nitrate imported from Chile.

Domestic production.—There are no deposits of potassium nitrate in the United States. In 1914 there was produced from imported raw materials 29,480,000 pounds of potassium nitrate, valued at $1,244,051. In 1918 production by four establishments amounted to 16,250,433 pounds, of which 8,176,382 pounds were sold for $2,206,788.

Imports.—The imports of crude nitrate in 1914 were 3,547,252 pounds, valued at $115,470. In 1915 the imports amounted to only 677,785 pounds, but increased greatly the next three years, amounting to 10,171,654 pounds in 1917 and 8,815,327 pounds in 1918. The largest imports on record were received during the fiscal year 1919, amounting to 34,557,048 pounds, valued at $1,298,291.

Prior to 1914 most of the imports were from Germany and British India, but with the beginning of the war the German imports ceased

and those from India fell off greatly. In 1916 and 1917 the largest imports were from the United Kingdom, with South America ranking second.

Imports for consumption.

POTASH, NITRATE OF (OR SALTPETER), CRUDE.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	17,470,648	$512,473		$0.029	
1910	do	11,848,195	349,199		.027	
1911	do	9,288,557	282,835		.03	
1912	do	6,172,441	213,258		.035	
1913	do	10,989,382	288,995		.026	
1914	do	3,547,252	115,470		.033	
1915	do	677,785	22,483		.033	
1916	do	5,412,130	734,123		.135	
1917	do	10,171,654	904,506		.089	
1918	do	8,815,327	956,853		.109	
1919	do	34,557,048	1,298,291		.037	

POTASH, NITRATE OF (OR SALTPETER), REFINED.

		Tons.				
1909	$11.20 per ton	185	$14,421	$2,076	$77.95	14.40
1910	do	1,165	115,457	13,054	99.00	11.30
1911	do	380	38,384	4,258	101.00	11.09
1912	do	198	23,896	2,214	120.68	9.27
1913	do	176	22,142	1,968	125.80	8.89
1914	do	34	4,306	385	126.65	8.94
1914	$7 per ton	128.5	15,867	899	123.48	5.67
1915	do	54	4,222	238	78.18	5.64
1916	do	2	749	14	374.50	1.87
1917	do	288	35,143	2,016	122.00	5.74
1918	do	43	16,193	301	376.60	1.86
1919	do	1	96	7	96.00	7.28

Imports by countries.

POTASH, NITRATE OF (OR SALTPETER), CRUDE.

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	510	$29	450,556	$7,741	132,710	$2,195
British India	17,400,555	510,357	11,306,332	339,690	9,144,837	280,351
United Kingdom	66,231	2,007	.....	.....	.....	.....
Canada	1,360	40	.....	.....	.....	.....
All others	2,000	40	366	9	.....	.....
Total	17,470,656	512,473	11,757,254	347,440	9,277,547	282,549

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	804,323	$13,593	4,964,700	$80,593	112,717	$2,167
British India	6,171,431	213,258	6,166,352	207,358	3,433,863	113,177
United Kingdom	.....	.....	2,240	30	.....	.....
Canada	.....	.....	23,178	1,014	.....	.....
All others	.....	.....	[1] 57,456	1,497	.....	.....
Total	6,975,754	226,851	11,213,926	290,492	3,546,580	115,344

[1] Chiefly Russia.

Imports by countries—Continued.

POTASH, NITRATE OF (OR SALTPETER) CRUDE—Continued.

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
British India	670,930	$22,083	1,106,770	$152,705	456,000	$82,300
United Kingdom			4,282,960	577,055	5,102,643	736,594
Canada			120,415	27,695		
Chile					3,467,520	77,720
All others	[1] 6,855	400	[2] 22,400	4,363	1,145,491	7,892
Total	677,785	22,483	5,532,545	761,818	10,171,654	904,506

Imported from—	1918		1919	
	Pounds.	Value.	Pounds.	Value.
British India	257,600	$34,500	11,646,550	$857,413
United Kingdom	6,915,332	747,696		
Canada			336	66
Chile	32,080	1,432	22,719,197	426,060
All others	1,615,355	171,390	190,929	14,752
Total	8,820,367	955,018	34,557,048	1,298,291

[1] Cuba. [2] Japan.

POTASSIUM PERMANGANATE.

Description.—Potassium permanganate forms purplish black crystals with a greenish metallic luster. These dissolve in water, giving a deep purple red solution. It is a powerful oxidizer, and when mixed with organic matter may cause spontaneous combustion.

Uses.—It is used largely as an oxidizer. It is used for bleaching, in dyeing shoe leather and for coloring wood a deep brown, for purifying ammonia and carbon dioxide. It is used to some extent in medicine, especially as a local disinfectant and germicide. It is an important reagent in analytical chemistry. It is estimated that over 50 per cent of the domestic production of potassium permanganate during the war was used in the manufacture of saccharin.

Manufacture.—The usual method of manufacture is to mix a solution of potassium hydroxide with powdered manganese ore and potassium chlorate or potassium nitrate, evaporate to dryness, and fuse the residue until it becomes pasty. This forms potassium manganate, which is then dissolved in water and treated with sulphuric acid, chlorine, or carbon dioxide. On evaporation the permanganate crystallizes.

Another method which is used in this country is to fuse manganese ore with caustic soda, producing sodium manganate. This is oxidized electrolytically to sodium permanganate and caustic soda. This solution is then treated with carbon dioxide, forming soda ash,

which crystallizes on evaporation, leaving the sodium permanganate in solution. The sodium permanganate is now treated with a potassium salt, preferably the carbonate, which produces the potassium permanganate. This is separated by crystallization. Sodium permanganate crystallizes very poorly.

Domestic production.—Prior to the war there was no production of permanganate of potash in this country. The shutting off of imports, the demands for war purposes, and the large demand for the manufacture of saccharin have greatly stimulated the industry in the United States. Several firms manufactured permanganate of potash in this country during the war. In 1918 there were nine producers and their output was 562,416 pounds. Of this quantity 530,837 pounds were sold for $922,746.

Imports.—In 1914 the imports of potassium permanganate were 1,351,855 pounds, nearly all of which came from Germany, but by 1916 they had fallen to 208,979 pounds, and in 1917 to 5,695 pounds. In 1918 the imports were 43,826 pounds. Some was imported from Japan, but when the prices fell these imports were reduced, as Japan was not able to export to this country at the lower prices.

Imports for consumption.

POTASH, PERMANGANATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	25 per cent	592,805	$40,572	$10,143	$0.068	25.00
1910	do	565,215	38,479	9,619	.067	25.00
1911	do	638,159	44,135	11,033	.069	25.00
1912	do	432,987	29,932	7,483	.069	25.00
1913	do	357,366	25,314	6,328	.071	25.00
1914	do	75,260	5,269	1,317	.070	25.00
1914	1 cent per pound	1,276,595	85,796	12,765	.067	14.88
1915	do	1,089,304	78,924	10,393	.076	13.17
1916	do	208,979	56,146	2,089	.269	3.72
1917	do	5,695	9,391	50	1.84	.54
1918	do	43,826	106,104	438	2.42	.41
1919	do	18,107	43,830	181	2.42	.41

POTASSIUM SULPHATE.

Description and uses.—Potassium sulphate in the pure state forms well-defined crystals which are soluble in water and have a bitter taste. It is used principally in the crude form as a fertilizer. It is also used for the production of potassium carbonate by the Leblanc process and in the manufacture of potash alum. Some is used by glass works.

Manufacture.—Large quantities of potassium sulphate are manufactured from kainite in Germany near Stassfurt. Kainite, which is a double sulphate of potassium and magnesium containing magnesium

chloride, is dissolved in water, and on concentrating this solution a mixed sulphate of potassium and magnesium separates. This, when treated with potassium chloride, forms potassium sulphate and magnesium chloride. The potassium sulphate, being the less soluble, crystallizes on evaporating the solution.

Potassium sulphate may also be made by treating potassium chloride with sulphuric acid. In this way hydrochloric acid is also produced.

Domestic production.—In 1918 the domestic production of sulphate of potash was 6,897 tons of crude salts containing 3,294 tons of actual potash (K_2O).

Imports.—Prior to the war all of that consumed in this country was imported from Germany, but there have been no imports from there since 1915. The total imports in 1914 were 45,139 tons, but had dropped to 661 tons in 1917, the greater part of which came from Japan. In 1918 only 135 tons were imported.

Imports for consumption.

POTASH, SULPHATE OF, CRUDE OR REFINED.

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Tons.		
1909	Free	27,239	$1,148,607	$42.17
1910	do	37,933	1,399,915	36.90
1911	do	47,441	1,952,370	41.15
1912	do	45,134	1,853,235	41.05
1913	do	42,877	1,798,369	41.94
1914	do	7,596	315,029	41.47
1914	do	37,389	1,572,462	42.06
1915	do	21,705	1,071,623	49.37
1916	do	2,427	197,808	81.50
1917	do	656	20,538	31.30
1918	do	136	19,837	145.86
1919	do	137	23,304	170.10

Imports by countries.

POTASH, SULPHATE OF.

[Free.]

Imported from—	1909		1910		1911	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	26,923	$1,132,396	37,987	$1,392,902	46,960	$1,927,504
Netherlands	.....	.....	88	4,082	100	3,076
United Kingdom	25	1,190	135	7,255	300	17,787
Belgium	206	10,309	.....	.....	31	1,710
All others	136	4,711	270	7,995	50	2,291
Total	27,290	1,148,606	38,480	1,412,234	47,441	1,952,368

Imports by countries—Continued.

POTASH, SULPHATE OF—Continued.

[Free.]

Imported from—	1912		1913		1914	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	43,831	$1,802,731	42,696	$1,751,661	43,993	$1,827,763
Netherlands	508	18,630	.....	.....	221	11,683
United Kingdom	62	4,093	.....	.....	915	57,827
Belgium	25	1,382	49	1,824	10	467
All others	.....	.....	.....	.....	.....	.....
Total	44,476	1,826,836	42,745	1,753,485	45,139	1,897,740

Imported from—	1915		1916		1917	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	18,973	$842,134	.....	.....	.....	.....
Netherlands	1,274	70,403	.....	.....	.....	.....
United Kingdom	54	3,126	.....	.....	.....	.....
Belgium	206	9,710	.....	.....	.....	.....
All others	1,345	146,388	2,423	$197,808	661	$20,538
Total	21,852	1,071,761	2,423	197,808	661	20,538

Imported from—	1918		1919	
	Tons.	Value.	Tons.	Value.
Germany	.....	.....	.....	.....
Netherlands	.....	.....	.....	.....
United Kingdom	.....	.....	.....	.....
Belgium	.....	.....	.....	.....
All others	.....	.....	.....	.....
Total	135	$19,837	137	$23,304

KELP.

Description.—The name kelp was originally applied to the ash obtained by burning seaweed. This was recovered for its soda and iodine content. The name has now been extended, especially in the United States, to apply to the weeds themselves, especially those which may be made to yield potash, iodine, and other valuable products.

Uses.—Kelp is used principally for the production of potash salts and iodine, though other valuable products may be obtained. Some of these are acetic acid, butyric acid, propionic acid, and acetone. It is reported that a process has been devised for obtaining alcohol in large quantities from kelp. Dried and ground kelp is sometimes used directly as a fertilizer.

Domestic production.—Very little kelp was utilized in this country before 1914, but the shortage of potash salts, due to the war in Europe caused the utilization of large quantities of seaweed along

coast. A number of plants started up for the manufacture of potash and other products from kelp and at least one of them had a capacity of close to 1,000 tons of fresh kelp per day.

Many of these plants have already shut down and the remainder probably will be compelled to if the price of potash goes down to anywhere near what it was before the war.

Imports.—Some kelp has been imported but the imports have been very small and irregular.

KAINITE.

Description.—Kainite is a natural product which occurs in the large salt deposits of Europe. It is a complex salt consisting of the sulphate of potash and the sulphate and chloride of magnesia and the water of crystallization. The commercial kainite contains at most only about 70 per cent of the mineral. When heated with water under pressure, it decomposes into a double sulphate of potassium and magnesium, potassium chloride, and magnesium chloride.

Uses.—Kainite is used in the crude state, without any treatment except grinding, as a fertilizer. Some of it is also used for the production of potassium sulphate.

Domestic production.—The United States produces no kainite, all that is used being imported.

Imports.—There have been no imports since 1916. All the kainite imported came from Germany. In 1914 the United States imported 541,846 tons. The imports have since decreased until in 1916 only 64 tons were imported.

Imports for consumption.

KAINITE.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Tons.		
1909	Free	344,526	$1,974,165	$5.73
1910	do	470,241	2,268,263	4.82
1911	do	580,474	2,607,105	4.49
1912	do	479,817	2,400,589	5.00
1913	do	466,184	2,149,689	4.61
1914	do	520,112	2,579,019	4.90
1915	do	79,124	444,996	5.62
1916	do	64	1,795	28.04
1917	do			
1918	do			

[1] Entered in 1909 as "Kainerite," kyanite, or cyanite, and kainite.

Imports by countries.

KAINITE.[1]

[Free.]

Imported from—	1912		1913		1914	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	484,882	$2,398,848	466,795	$2,154 977	536,904	$2,554,567
Netherlands	250	913			4,932	24,977
Belgium					10	75
Total	485,132	2,399,761	466,795	2,154,977	541,846	2,579,619

Imported from—	1915		1916		1917–19	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	74,811	$372,294				
Netherlands	1,333	9,201				
France	2,860	63,265				
Cuba			6	$300		
Peru			58	1,495		
Total	79,004	444,760	64	1,795		

[1] Included in "All other fertilizers" in 1909 and 1910 and in "Manure salts and kainite" in 1911. There was no import in 1917, 1918, and 1919.

Foreign production.—The salt mines near Stassfurt, Germany, furnished nearly all the kainite consumed. These mines are controlled by a syndicate which fixes the output of each mine and the price of the products.

During the calendar year of 1913 there were sold by the German Potash Syndicate in the United States 445,706 tons of kainite, most of which went to five large fertilizer companies. Nineteen hundred and thirteen was the last calendar year during which the exports to the United States were normal.

HARDSALT OR "HARTSALZ."

Description and uses.—Hardsalt is the name given to one of the natural products obtained from the Stassfurt salt deposits. It is a mixture of about 20 per cent sylvine, 25 per cent kieserite, and 55 per cent rock salt. Hardsalt is used principally in the crude state as a fertilizer.

Imports.—All that is used in this country is imported from Germany. The amount used by the seven largest fertilizer companies in 1913 was 9,291 tons.

MANURE SALT.

Description.—Manure salt is a name applied to a mixture of various crude salts which is used chiefly as a fertilizer. Manure salt is of rather indefinite composition, but contains potassium chloride and is sold according to its content of K_2O.

Manufacture.—It is produced by a partial purification of natural products and is essentially a mixture of potassium chloride, magnesium sulphate, and sodium chloride.

Manure salt is sold in two grades, the "single manure salt," sold on a basis of 20 per cent K_2O, and the "double manure salt," sold on a basis of 48 per cent K_2O.

Imports.—Imports of manure salts during the calendar year 1913 amounted to 223,687 tons,[3] valued at $2,245,509, but have fallen off rapidly since then, so that during the fiscal year 1918 the imports were only 225 tons, valued at $9,047.

Imports by countries.

MANURE SALTS.[a]

[Free.]

Imported from—	1911[b]		1912		1913	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	738,947	$3,888,164	191,242	$1,788,783	168,843	$1,755,007
Netherlands	.....	.....	374	2,300	1,300	11,982
United Kingdom	1,308	10,824	.....	.....	11	811
All others	137	3,316	1,122	22,988	1,648	26,258
Total	740,392	3,902,304	192,738	1,814,071	171,802	1,794,058

Imported from—	1914		1915		1916	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	256,703	$2,696,671	60,285	$650,749	.....	.....
Netherlands	2,247	19,805	2,442	40,636	.....	.....
United Kingdom	1,875	36,715	2,736	49,701	2,270	$41,785
All others	517	14,050	599	19,613	1	40
Total	261,342	2,767,241	66,062	760,699	2,271	41,825

Imported from—	1917		1918		1919	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	.....	.....	.....	.....	.....	.....
Netherlands	.....	.....	.....	.....	.....	.....
United Kingdom	324	$7,794	190	$8,872	.....	.....
All others	.....	.....	.....	.....	.....	.....
Total	324	7,794	190	8,872	.....	.....

[a] Included in "All other fertilizers" in 1910.

[b] "Manure salts and kainit."

[3] Figures from Mineral Resources, 1917.

Imports for consumption.

MANURE SALTS (INCLUDING DOUBLE MANURE SALTS).

[N. s. p. f.]

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Tons.		
1910	Free	90,933	$928,357	$10.20
1911	do	169,105	1,265,867	7.90
1912	do	185,682	1,828,126	9.85
1913	do	172,556	1,798,773	10.42
1914	do	260,976	2,757,013	10.56
1915	do	66,411	757,151	11.40
1916	do	2,278	42,368	16.00
1917	do	324	7,794	24.05
1918	do	225	9,047	40.21

Imports by countries.

POTASH, ALL OTHER SALTS OF.[1]

[Dutiable.]

Imported from—	1911		1912		1913	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	4,271,328	$460,888	2,000,591	$188,250	2,464,585	$259,247
United Kingdom	772,139	67,345	762,353	50,252	1,987,180	121,831
France	45,386	4,182	311,018	27,857	411,158	42,091
Netherlands					110,588	10,806
All others	561,785	54,158	335,541	29,880	308,633	29,915
Total	5,650,638	586,573	3,409,503	296,239	5,282,144	463,890

Imported from—	1914		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	2,932,304	$258,464	2,765,858	$266,931	143,188	$11,465
England	1,924,311	179,532	465,531	42,310	120	14
France	435,671	48,300	11,533	1,260	11,246	17,703
Netherlands	167,649	19,001	584,909	55,195	441	47
All others	315,653	32,255	217,443	29,893	125,294	77,659
Total	5,775,588	537,592	4,045.274	395,589	280,289	106,888

Imported from—	1917		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany					23,406	$1,515
England	662	$242	14,000	$4,452	2,800	1,776
France	4,408	5,510			11,023	3,185
Chile	560,000	18,751				
Japan	519,770	252,874	1,624,548	782,214	183,869	139,540
All others	11,738	11,598	23,605	16,961	24,690	1,721
Total	1,096,578	289,975	1,662,153	803,627	247,789	147,757

[1] Included in all other chemicals in 1909 and 1910.

Wholesale prices of potash.

[Data from Oil, Paint, and Drug Reporter.][a]

	Prices.
ALUM (POTASSIUM-ALUMINIUM SULPHATE).	
[Per pound, New York, spot.]	
Jan. 2, 1912	$0.01½–$0.02
Apr. 1, 1912	.01½– .02
July 1, 1912	.01½– .02
Sept. 20, 1912	.01½– .02
Dec. 30, 1912	.01½– .02
Mar. 31, 1913	.01½– .02
June 30, 1913	.01½– .02
Sept. 29, 1913	.01½– .02
Dec. 29, 1913	.01½– .02
Mar. 30, 1914	.01½– .02
June 29, 1914	.01½– .02
Sept. 28, 1914	.02½– .03
Dec. 28, 1914	.02½– .02¾
Mar. 29, 1915	.02½– .02¾
June 28, 1915	.02½– .02¾
Sept. 27, 1915	.03½– .05
Jan. 3, 1916	.04 – .05
Apr. 3, 1916	.04½– .04½
July 3, 1916	.04 – .04½
Oct. 2, 1916	.04 – .04½
Jan. 1, 1917	.04 – .04½
Apr. 2, 1917	.04 – .04½
July 2, 1917	.04½– .05
Oct. 1, 1917	.04½– .05
Dec. 31, 1917	.08 – .08¾
Apr. 1, 1918	.09 – .09½
July 1, 1918	.08 – .09
October, 1918	.11½– .12
January, 1919	.11 – .12
April, 1919	.11 – .12
July, 1919	.08 – .10
October, 1919	.08 – .10
January, 1920	.08 – .09
April, 1920	.08 – .09
ACETATE OF POTASH.	
[Per pound, New York, spot.]	
June 28, 1915	.33 – .34
Sept. 27, 1915	.40 – .42
Jan. 3, 1916	.50 – .51
Apr. 3, 1916	1.45 – 1.46
July 3, 1916	1.45 – 1.46
Oct. 2, 1916	1.25 – 1.26
Jan. 1, 1917	1.25 – 1.26
Apr. 2, 1917	1.25 – 1.26
July 2, 1917	1.25 – 1.26
Oct. 1, 1917	1.30 – 1.32
Dec. 31, 1917	1.50
April, 1918	1.50
July, 1918	1.50
October, 1918	1.50
January, 1919	1.10 – 1.15
April, 1919	.95 – 1.00
July, 1919	.95 – 1.00
October, 1919	.70 – .75
January, 1920	.70 – .75
April, 1920	.65 – .70
BICARBONATE OF POTASH.	
[Per pound, New York, spot.]	
June 28, 1915	.30 – .32
Sept. 27, 1915	.37 – .40
Jan. 3, 1916	.45 – .50
Apr. 3, 1916	1.40
July 3, 1916	1.65
Oct. 2, 1916	1.25 – 1.35
Jan. 1, 1917	1.40 – 1.50
Apr. 2, 1917	1.30 – 1.40
July 2, 1917	1.30 – 1.40
BICARBONATE OF POTASH—Con.	
Oct. 1, 1917	$1.25 –$1.30
Dec. 31, 1917	1.25 – 1.50
April, 1918	1.25 – 1.50
July, 1918	1.25 – 1.50
October, 1918	.70 – .75
January, 1919	.65 – .70
April, 1919	.65 – .70
July, 1919	.30 – .35
October, 1919	.31 – .36
January, 1920	.31 – .36
April, 1920	.35 – .48
BICHROMATE OF POTASH.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.07⅞– .07⅞
Apr. 1, 1912	.07¼– .07⅞
July 1, 1912	.07¼– .07⅞
Sept. 30, 1912	.06¾– .07
Dec. 30, 1912	.06¾– .07
Mar. 31, 1913	.06¾– .07
June 30, 1913	.06¾– .07
Sept. 29, 1913	.06¾– .07
Dec. 29, 1913	.06¾– .07
Mar. 28, 1914	.06¾– .07
June 29, 1914	.06¾– .07
Sept. 28, 1914	.15
Dec. 28, 1914	.12 – .13
Mar. 29, 1915	.15½– .16
June 28, 1915	.21
Sept. 27, 1915	.20 – .21
Jan. 3, 1916	.45
Apr. 4, 1916	.75
July 3, 1916	.43 – .45
Oct. 2, 1916	.38 – .50
Jan. 1, 1917	.42 – .43
July 2, 1917	.36 – .37
Oct. 1, 1917	.45 – .50
Dec. 31, 1917	.43½– .44
April, 1918	.43¾– .45
July, 1918	.45 – .46
October, 1918	.42 – .45
January, 1919	.38 – .41
April, 1919	.35 – .38
July, 1919	.25 – .33
October, 1919	.26 – .28
January, 1920	.30 – .32
April, 1920	.38 – .40
CAUSTIC POTASH.	
[Per pound, New York, spot.]	
Jan. 2, 1912	.03¾– .048
Apr. 1, 1912	.03¾– .048
July 1, 1912	.03¾– .048
Sept. 30, 1912	.03¾– .048
Dec. 30, 1912	.03¾– .048
Mar. 31, 1913	.03¾– .048
June 30, 1913	.03 – .04¾
Sept. 29, 1913	.03 – .04¾
Sept. 28, 1914	.17½– .20
Dec. 28, 1914	.07 – .08
Mar. 29, 1915	.22 – .25
June 28, 1915	.38 – .40
Dec. 31, 1917[1]	.63 – .64
Apr. 8, 1918[1]	.63½– .65
July 1, 1918[1]	.61 – .62
October, 1918[1]	.60 – .62
January, 1919[1]	.55 – .60
April, 1919[1]	.42 – .44
July, 1919	.28 – .30
October, 1919	.23 – .30
January, 1920	.23 – .25
April, 1920	.25 – .28

[a] When exact date is not specified, the quotation was taken on or about the first of the month.
[1] 70 to 75 per cent KOH.

Wholesale price of potash—Continued.

	Prices.
CAUSTIC POTASH (88 TO 92) PER CENT).	
[Per pound, New York, spot.]	
Sept. 27, 1915	$0.39 -$0.41
Jan. 3, 1916	.65 - .70
Apr. 3, 1916	.95 - 1.00
July 3, 1916	.83 - .90
Oct. 2, 1916	.85 - .90
Jan. 1, 1917	.90 - .95
Apr. 2, 1917	.88 - .90
July 2, 1917	.84 - .86
Oct. 1, 1917	.85 - .90
Dec. 31, 1917	.83 - .84
Apr. 8, 1918	.83½ - .85
July 1, 1918	.80 - .81
October, 1918	.70 - .72
January, 1919	.67 - .70
April, 1919	.50 - .52
July, 1919	.35 - .40
October, 1919	.28 - .35
January, 1920	.30 - .32
April, 1920	.31 - .35
CITRATE OF POTASH.	
[Per pound, New York, spot.]	
Sept. 28, 1914	.69 - .70
Dec. 28, 1914	.69 - .70
Mar. 29, 1915	.69 - .70
June 28, 1915	.69 - .70
Sept. 27, 1915	.73 - .75
Jan. 3, 1916 [2]	.73 - .75
Apr. 3, 1916 [2]	1.70 - 1.72
July 3, 1916 [2]	1.70 - 1.72
Oct. 2, 1916 [2]	1.50
Jan. 1, 1917 [2]	1.50
Apr. 2, 1917 [2]	1.54 - 1.56
July 2, 1917 [2]	1.54 - 1.56
Oct. 1, 1917 [2]	1.54 - 1.58
Dec. 31, 1917 [2]	1.60
April, 1918	1.60
July, 1918	1.60
October, 1918	1.70
January, 1919	1.78
April, 1919	2.02
July, 1919	1.84
October, 1919	1.84
January, 1920	1.78
April, 1920	1.78
CYANIDE OF POTASH, BULK.[4]	
[Per pound, New York, spot.]	
Jan. 1, 1912	.20 - .24
Apr. 1, 1912	.20 - .24
July 1, 1912	.20 - .24
Sept. 30, 1912	.19 - .24
Dec. 30, 1912	.19 - .24
Mar. 31, 1913	.19 - .24
June 30, 1913	.19 - .24
Sept. 29, 1913	.19 - .24
Dec. 29, 1913	.19 - .22
Mar. 28, 1914	.19 - .22
June 29, 1914	.19 - .22
Sept. 28, 1914	.22 - .23
Dec. 28, 1914	.25 - .26
Mar. 29, 1915	.18 - .25
June 28, 1915	.25 - .29
Sept. 27, 1915	.25 - .29
Jan. 3, 1916	Not listed.
Apr. 3, 1916	.37 - .38
July 3, 1916	.37 - .38
Oct. 2, 1916	1.00 - 1.20
Jan. 1, 1917 [5]	2.25 - 2.30

	Prices.
CYANIDE OF POTASH, BULK—Con.	
Apr. 2, 1917	$2.00 -$2.10
July 2, 1917	2.25 - 2.30
Oct. 1, 1917	2.25 - 2.50
Dec. 31, 1917	.60 - .70
April, 1918	.60 - .70
July, 1918	.60 - .70
October, 1918	.60 - .70
January, 1919	.60 - .70
CARBONATE OF POTASH, CALCINED (96 to 98 per cent).	
[Per pound, New York, spot.]	
Jan. 2, 1912	.0425- .0475
Apr. 2, 1912	.0425- .0475
July 1, 1912	.0425- .0475
Sept. 30, 1912	.0425- .0475
Dec. 30, 1912	.0425- .0475
Mar. 28, 1913	.0422- .0475
June 30, 1913	.0415- .0450
Sept. 29, 1913	.0425- .0450
Dec. 29, 1913	.0425- .0450
Mar. 30, 1914	.04½ - .04¾
June 29, 1914	.04¾ - .04¾
Sept. 28, 1914	.19
Dec. 28, 1914	.0725- .08
Mar. 29, 1915	.180 - .1850
June 28, 1915	.28
Sept. 27, 1915	.28 - .30
Jan. 3, 1916	.45 - .50
Apr. 3, 1916	1.10
July 3, 1916	.95 - 1.00
Oct. 2, 1916	.60
Jan. 1, 1917	.50 - .60
Apr. 2, 1917 [6]	.70
July 2, 1917 [6]	.70
Oct. 1, 1917 [6]	.70
Dec. 31, 1917	.60 - .80
Apr. 1, 1918	.65 - .85
July 1, 1918	.65 - .75
October, 1918	.55 - .75
January, 1919	.40
April, 1919	.26 - .28
July, 1919	.21 - .22
October, 1919	Nominal.
January, 1920	.35 - .40
April, 1920	Nominal.
CARBONATE OF POTASH, CALCINED (80 TO 85 PER CENT).	
[Per pound, New York, spot.]	
Jan. 2, 1912	.03¼ - .04
Apr. 1, 1912	.03¼ - .04
July 1, 1912	.03¼ - .04
Sept. 30, 1912	.03¼ - .04
Dec. 30, 1912	.034- .03⅝
Mar. 31, 1913	.034- .03⅝
June 30, 1913	.034- .03⅝
Sept. 29, 1913	.034- .03⅝
Dec. 29, 1913	.03¼ - .033
Mar. 30, 1914	.031- .03¼
June 29, 1914	.03- .03¼
Sept. 28, 1914	.17
Dec. 28, 1914	.06 - .07
Mar. 29, 1915	.14 - .14½
June 28, 1915	.20
Sept. 27, 1915	.23 - .24
Jan. 3, 1916	.45 - .50
Apr. 3, 1916	.90
July 3, 1916	.80 - .83
Oct. 2, 1916	.50
Jan. 1, 1917	.38 - .40

[2] Per cent not stated.
[3] 90 per cent.
[4] Not listed later than January, 1919.
[5] Bulk.
[6] Cyanide mixture.
[8] Nominal.

Wholesale price of potash—Continued.

	Prices.
CARBONATE OF POTASH, CALCINED (80 TO 85 PER CENT)—Contd.	
Apr. 2, 1917	$0.35 -$0.40
July 2, 1917	.45
Oct. 1, 1917	.50
Dec. 31, 1917	.50 - .55
Apr. 1, 1918	.40 - .45
July 1, 1918	.38 - .40
October, 1918	.35 - .38
January, 1919	.30 - .32
April, 1919	.17 - .18
July, 1919	.12 - .14
October, 1919	.25
January, 1920	.24 - .26
April, 1920	.21 - .23
CHLORATE OF POTASH, CRYSTALS.	
[Per pound, New York, spot.]	
Jan. 2, 1912 [9]	.08¼- .09½
Apr. 1, 1912 [9]	.08¼- .09½
July 1, 1912 [9]	.08¼- .09½
Sept. 30, 1912 [9]	.08¼- .09½
Dec. 30, 1912	.08¼- .09½
Mar. 31, 1913	.08¼- .09½
June 30, 1913	.08¼- .09½
Sept. 29, 1913	.08¼- .09½
Dec. 29, 1913	.07¼- .07¾
Mar. 30, 1914	.07¼- .07¾
June 29, 1914	.07¼- .07¾
Dec. 28, 1914	.15
Mar. 29, 1915	.25 - .30
June 28, 1915	.30 - .30½
Sept. 27, 1915	.34 - .35
Jan. 3, 1916	.45 - .50
Apr. 3, 1916	.75
July 3, 1916	.53 - .70
Oct. 2, 1916	.48 - .70
Jan. 1, 1917	.65 - .70
Apr. 2, 1917	.60 - .70
July 2, 1917	.55 - .75
Oct. 1, 1917	.57½- .60
Dec. 31, 1917	.40 - .41
Apr. 8, 1918	.41 - .42½
July 1, 1918	.39 - .41
October, 1918	.40 - .41
January, 1919	.39 - .41
April, 1919	.40
July, 1919	.25 - .30
October, 1919	.20
January, 1920	.15
April, 1920	.15
CARBONATE OF POTASH, HYDRATED (80 TO 85 PER CENT).	
[Per pound, New York, spot.]	
Jan. 1, 1912	.03¾- .04½
Apr. 1, 1912	.03¾- .04½
July 1, 1912	.03¾- .04½
Sept. 30, 1912	.03⅞- .04¼
Dec. 30, 1912	.03¾- .04¼
Mar. 31, 1913	.03⅞- .04¼
June 30, 1913	.03⅞- .04¼
Sept. 29, 1913	.03⅞- .04⅜
Dec. 29, 1913	.03⅞- .04⅜
Mar. 28, 1914	.03⅞- .04⅜
June 29, 1914	.03⅞- .04⅜
Sept. 28, 1914	.22
Mar. 29, 1915	.16 - .17
June 28, 1915	.20
Sept. 27, 1915	.24 - .25
Jan. 3, 1916	.45 - .50
Apr. 3, 1916	1.15
July 3, 1916	.95 - 1.00
Oct. 2, 1916	.70
Jan. 1, 1917	.55 - .65

	Prices.
CARBONATE OF POTASH, HYDRATED (80 to 85 PER CENT—Continued.	
Dec. 31, 1917 [10]	$1.00 -$1.25
Apr. 8, 1918 [10]	1.00 - 1.25
July, 1918	Nominal.
October, 1918	.85 - .95
January, 1919	.85 - .95
April, 1919	.80 - .90
July, 1919	.55 - .65
October, 1919	.29 - .35
January, 1920	.33 - .35
April, 1920	.31 - .32
IODIDE OF POTASH, BULK.	
[Per pound, New York, spot.]	
Jan. 1, 1912	2.10 - 2.15
Apr. 1, 1912	2.10 - 2.15
July 1, 1912	2.40 - 2.45
Sept. 30, 1912	2.60 - 2.65
Dec. 30, 1912	2.60 - 2.65
Mar. 31, 1913	2.60 - 2.65
June 30, 1913	2.60 - 2.65
Sept. 29, 1913	2.95 - 3.00
Dec. 29, 1913	2.95 - 3.00
Mar. 28, 1914	2.95 - 3.00
June 29, 1914	2.95 - 3.00
Sept. 28, 1914	3.15 - 3.20
Dec. 28, 1914	3.15 - 3.20
Mar. 29, 1915	3.15 - 3.20
June 28, 1915	3.15 - 3.20
Sept. 27, 1915	3.70 - 3.75
Jan. 3, 1916	3.70 - 3.75
Apr. 3, 1916	4.30 - 4.35
July 3, 1916	3.90 - 3.95
Oct. 2, 1916	3.75 - 3.80
Jan. 1, 1917	3.45 - 3.50
Apr. 2, 1917	2.90 - 2.95
July 2, 1917	2.90 - 2.95
Oct. 1, 1917	2.90 - 2.95
Dec. 31, 1917 [11]	3.75 - 3.80
April, 1918 [11]	3.75 - 3.80
July, 1918 [11]	3.75 - 3.80
October, 1918	3.75 - 3.80
January, 1919	3.50 - 3.55
April, 1919	3.50 - 3.55
July, 1919	3.30 - 3.35
October, 1919	3.55 - 3.60
January, 1920	3.35 - 3.40
April, 1920	3.10 - 3.15
MURIATE OF POTASH (80 TO 85 PER CENT; BASIS, 80 PER CENT).	
[Per ton, New York, spot.]	
Jan. 2, 1912	38.05
Apr. 1, 1912	38.05
July 1, 1912	38.55
Sept. 30, 1912	38.55
Dec. 30, 1912	38.55
Mar. 31, 1913	38.55
June 30, 1913	38.55
Sept. 29, 1913	38.65
Dec. 29, 1913	38.65
Mar. 30, 1914	39.07
June 29, 1914	39.07
Sept. 28, 1914	39.57
Dec. 2, 1914	39.57
Mar. 29, 1915	160.00
June 28, 1915	230.00- 250.00
Sept. 27, 1915	245.00- 250.00
Jan. 3, 1916	475.00- 500.00
Apr. 3, 1916	415.00- 420.00
July 3, 1916	290.00- 350.00
Oct. 2, 1916	400.00- 420.00
Jan. 1, 1917	450.00- 460.00

[9] F. o. b. works.
[10] Carbonate, hydrated.
[11] Listed "Iodine, potassium."

Wholesale prices of potash—Continued.

	Prices.
MURIATE OF POTASH (80 TO 85 PER CENT; BASIS, 80 PER CENT)—Con.	
Apr. 2, 1917	$425.00-$450.00
July 2, 1917	350.00- 360.00
Oct. 1, 1917	325.00- 350.00
Dec. 31, 1917	350.00
April, 1918	345.00- 350.00
July 1, 1918	310.00
October, 1918	260.00- 310.00
January, 1919	260.00- 310.00
April, 1919	260.00- 275.00
July, 1919	85.00
October, 1919	110.00
January, 1920	200.00- 240.00
April, 1920	200.00- 240.00
MURIATE OF POTASH (MINIMUM, 95 PER CENT; BASIS, 80 PER CENT).	
[Per ton, New York, spot.]	
Jan. 2, 1912	39.65
Apr. 1, 1912	39.65
July 1, 1912	40.15
Sept. 30, 1912	40.15
Dec. 30, 1912	40.15
Mar. 31, 1913	40.15
June 30, 1913	40.15
Sept. 29, 1913	40.15
Dec. 29, 1913	40.15
Mar. 30, 1914	40.75
June 29, 1914	40.75
Sept. 28, 1914	41.25
Dec. 28, 1914	41.25
Mar. 29, 1915	160.00
June 28, 1915	230.00- 250.00
Sept. 27, 1915	[12]
Jan. 3, 1916	[12]
Apr. 3, 1916	[12]
July 3, 1916	300.00- 310.00
Oct. 2, 1916	375.00
Jan. 1, 1917	375.00
Apr. 2, 1917	375.00
July 2, 1917	360.00
Oct. 1, 1917	[12]
Dec. 31, 1917	[12]
Apr. 1, 1918	[12]
July 1, 1918	325.00
October, 1918	260.00- 325.00
January, 1919	260.00- 325.00
April, 1919	260.00- 325.00
July, 1919	[12]
October, 1919	[12]
January, 1920	[12]
April, 1920	[12]
MURIATE OF POTASH (MINIMUM, 98 PER CENT; BASIS, 80 PER CENT).	
[Per ton, New York, spot.]	
Jan. 2, 1912	40.50
Apr. 1, 1912	40.50
July 1, 1912	41.00
Sept. 30, 1912	41.00
Dec. 30, 1912	41.00
Mar. 31, 1913	41.00
June 30, 1913	41.00
Sept. 29, 1913	41.00
Dec. 29, 1913	41.00
Mar. 30, 1914	41.65
June 29, 1914	41.65
Sept. 28, 1914	42.15
Dec. 28, 1914	42.15
Mar. 29, 1915	160.00
June 28, 1915	230.00- 250.00
Sept. 27, 1915	[12]
Jan. 3, 1916	[12]
Apr. 3, 1916	[12]
July 3, 1916	[12]

	Prices.
MURIATE OF POTASH) MINIMUM, 98 PER CENT; BASIS, 80 PER CENT)—Continued.	
Oct. 2, 1916	[12]
Jan. 1, 1917	[12]
Apr. 2, 1917	[12]
July 2, 1917	[12]
Oct. 1, 1917	[12]
Dec. 31, 1917	[12]
April, 1918	[12]
July, 1918	$325.00
October, 1918	$260.00- 325.00
January, 1919	260.00- 325.00
April, 1919	260.00
July, 1919	[12]
October, 1919	[12]
January, 1920	[12]
April, 1920	[12]
PERMANGANATE OF POTASH, U. S. P.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.09½- .10½
Apr. 1, 1912	.09½- .10
July 1, 1912	.09½- .10
Sept. 30, 1912	.09½- .10
Dec. 30, 1912	.09½- .10
Mar. 31, 1913	.09½- .10
June 30, 1913	.09½- .10
Sept. 29, 1913	.09½- .10
Dec. 29, 1913	.09½- .10
Mar. 28, 1914	.09½- .10
June 29, 1914	.09½- .10
Sept. 28, 1914	.55 - .60
Dec. 28, 1914	.14 - .15
Mar. 29, 1915	.55 - .65
June 28, 1915	.70 - .72½
Sept. 27, 1915	1.15
Jan. 3, 1916	1.75
Apr. 3, 1916	1.90 - 2.05
July 3, 1916	1.60 - 1.70
Oct. 2, 1916	1.75 - 2.00
Jan. 1, 1917	2.75 - 3.00
Apr. 12, 1917 [12]	3.50 - 4.00
July 2, 1917	4.00 - 4.50
Oct. 1, 1917	4.00 - 4.25
Dec. 31, 1917	4.00 - 4.10
April, 1918	4.00 - 4.10
July 1, 1918	2.00 - 3.75
October, 1918	1.75 - 2.00
January, 1919	1.35 - 1.60
April, 1919	.60 - .70
July, 1919	.50 - .60
October, 1919	.65 - .70
January, 1920	.65 - .68
April, 1920	.70 - .80
CHLORATE OF POTASH, POWDERED.	
[Per pound, New York, spot.]	
Jan. 2, 1912	.08½- .09½
Apr. 1, 1912	.08½- .09½
July 1, 1912	.08½- .09½
Sept. 30, 1912	.08½- .09½
Dec. 30, 1912	.08½- .09½
Mar. 31, 1913	.08½- .09½
June 30, 1913	.08½- .09½
Sept. 29, 1913	.08½- .09½
Dec. 29, 1913	.07½- .08
Mar. 30, 1914	.07½- .08
June 29, 1914	.07½- .08
Dec. 28, 1914	.15½
Mar. 29, 1915	.25 - .30
June 28, 1915	.30 - .30½
Sept. 27, 1915	.34 - .35
Jan. 3, 1916	.45 - .50
Apr. 3, 1916	.75

[12] Nominal.

Wholesale prices of potash—Continued.

	Prices.
CHLORATE OF POTASH, POWDERED—Continued.	
July 3, 1916	$0.53 –$0.70
Oct. 2, 1916	.48 – .70
Jan. 1, 1917	.65 – .70
Apr. 2, 1917	.60 – .70
July 2, 1917	.55 – .75
Oct. 1, 1917	.57½ – .60
Dec. 31, 1917	.40 – .41
April, 1918	.41 – .42
July, 1918	.39 – .41
October, 1918	.40 – .41
January, 1919	.39 – .41
April, 1919	.40
July, 1919	.25 – .30
October, 1919	.20
January, 1920	.15
April, 1920	.15
PRUSSIATE OF POTASH, RED.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.26 – .30
Apr. 1, 1912	.26 – .30
July 1, 1912	.26 – .60
Sept. 30, 1912	.28 – .32
Dec. 30, 1912	.33
Mar. 31, 1913	.33
June 30, 1913	.33
Sept. 29, 1913	.33
Dec. 29, 1913	.23
Mar. 28, 1914	.21½
June 29, 1914	.21 – .23
Dec. 28, 1914	.55
Mar. 29, 1915	.55
June 28, 1915	1.25
Sept. 27, 1915	2.35
Jan. 3, 1916	5.00
Oct. 2, 1916	1.75 – 2.00
Jan. 1, 1917	2.50 – 3.00
July 2, 1917	2.75 – 2.90
Oct. 1, 1917	2.80 – 2.95
Dec. 31, 1917	2.65 – 3.00
Apr. 8, 1918	2.80 – 2.90
July, 1918	2.60 – 2.70
October, 1918	2.30 – 2.50
January, 1919	2.00 – 2.25
April, 1919	1.00 – 1.25
July, 1919	.75 – .80
October, 1919	1.10 – 1.20
January, 1920	1.00 – 1.10
April, 1920	1.00 – 1.10
PRUSSIATE OF POTASH, YELLOW.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.13½ – .13½
Apr. 1, 1912	.13⅛ – .13½
July 1, 1912	.14
Sept. 30, 1912	.18 – .20
Dec. 30, 1912	.18 – .22
Mar. 31, 1913	.16½ – .19
June 30, 1913	.16 – .18
Sept. 29, 1913	.15⅞ – .17⅞
Dec. 29, 1913	.13¾
Mar. 28, 1914	.13 – .13½
June 29, 1914	.12½ – .12⅝
Sept. 28, 1914	.34 – .36
Dec. 28, 1914	.22 – .24
Mar. 29, 1915	.42 – .48
June 28, 1915	.75 – .90
Sept. 27, 1915	.82½ – .85
Jan. 3, 1916	.90 – 1.00
Apr. 3, 1916	1.75 – 1.80
July 3, 1916	1.20 – 1.30
Oct. 2, 1916	.65 – .75
Jan. 1, 1917	.92 – .95
July 2, 1917	1.00 – 1.05
Oct. 1, 1917	1.25

	Prices.
PRUSSIATE OF POTASH, YELLOW—Continued.	
Dec. 31, 1917	$1.25 –$1.30
Apr. 8, 1918	1.25 – 1.27
July, 1918	1.05 – 1.10
October, 1918	.95 – 1.00
January, 1919	.75 – .80
April, 1919	.50 – .55
July, 1919	.25 – .30
October, 1919	.45 – .55
January, 1920	.36 – .38
April, 1920	.35 – .38
SULPHATE OF POTASH (90 TO 95 PER CENT; BASIS, 90 PER CENT).	
[Per ton.]	
Jan. 1, 1912	46.30
Apr. 1, 1912	46.30
July 1, 1912	46.80
Sept. 30, 1912	46.80
Dec. 30, 1912	46.80
Mar. 31, 1913	46.80
June 30, 1913	46.80
Sept. 29, 1913	46.80
Dec. 29, 1913	46.80
Mar. 28, 1914 [13]	47.57
June 29, 1914	47.57
Sept. 28, 1914	48.07
Dec. 28, 1914	48.07
Mar. 29, 1915	140.00
June 28, 1915	205.00
Sept. 27, 1915	205.00– 210.00
Jan. 3, 1916	440.00
Apr. 3, 1916	325.00– 350.00
July 3, 1916	275.00– 300.00
Oct. 2, 1916	275.00– 300.00
Jan. 1, 1917	275.00– 300.00
Apr. 2, 1917	275.00– 300.00
July 2, 1917	275.00– 300.00
Oct. 1, 1917	300.00
Dec. 31, 1917	350.00– 400.00
Apr. 1, 1918	375.00– 400.00
July 1, 1918	350.00
October, 1918	325.00– 350.00
January, 1919	300.00
April, 1919	225.00
July, 1919	[12]
October, 1919	[12]
January, 1920	[12]
April, 1920	360.00
DOUBLE MANURE SALT (48 TO 53 PER CENT; BASIS, 48 PER CENT).	
[Per ton, New York, spot.]	
Jan. 1, 1912	24.45
Apr. 1, 1912	24.45
July 1, 1912	24.95
Sept. 30, 1912	24.95
Dec. 30, 1912	24.95
Mar. 31, 1913	24.95
June 30, 1913	24.95
Sept. 29, 1913	24.95
Dec. 29, 1913	24.95
Mar. 29, 1914 [14]	25.04
June 29, 1914 [14]	25.04
Sept. 28, 1914	25.54
Dec. 28, 1914	25.54
Mar. 29, 1915 [14]	55.00
June 28, 1915 [14]	57.00
Sept. 27, 1915	105.00
Jan. 3, 1916	105.00
Apr. 3, 1916	105.00
July 3, 1916	105.00
Oct. 2, 1916	105.00
Jan. 1, 1917	105.00
Apr. 2, 1917	105.00
July 2, 1917	105.00
Oct. 1, 1917	[15]

[12] Nominal.
[13] In bags.
[14] In bags.
[15] Nominal from October, 1917, to April, 1920.

Wholesale prices of potash.

	Prices.
MANURE SALT (MINIMUM, 20 PER CENT K_2O IN BULK).	
[Per ton, New York, spot.]	
Jan. 1, 1912	$13.30
Apr. 1, 1912	13.30
July 1, 1912	13.50
Sept. 30, 1912	13.50
Dec. 30, 1912	13.50
Mar. 31, 1913	13.50
June 30, 1913	13.50
Sept. 29, 1913	13.50
Dec. 29, 1913	13.50
Mar. 28, 1914	13.58
June 29, 1914	13.58
Sept. 28, 1914	13.78
Dec. 28, 1914	13.78
Mar. 29, 1915	27.00
June 28, 1915	50.00
Sept. 27, 1915	60.00
Jan. 3, 1916	60.00
Apr. 3, 1916	$50.00–60.00
July 3, 1916	50.00–60.00
Oct. 2, 1916	50.00–60.00
Jan. 1, 1917	50.00–60.00
Apr. 2, 1917 [14]	50.00–60.00
July 2, 1917	50.00–60.00
Oct. 1, 1917	(15)
HARD SALT (MINIMUM, 16 PER CENT K_2O IN BULK).	
[Per ton, New York, spot.]	
Jan. 1, 1912	10.65
Apr. 1, 1912	10.65
July 1, 1912	10.85
Sept. 30, 1912	10.85
Dec. 30, 1912	10.85
Mar. 31, 1913	10.85
June 30, 1913	10.85
Sept. 29, 1913	10.85
Dec. 29, 1913	10.85
Mar. 28, 1914	10.87
June 29, 1914	10.87
Sept. 28, 1914	11.07
Dec. 28, 1914	11.07
June 28, 1915	40.00–50.00
Sept. 27, 1915	40.00–50.00
Jan. 3, 1916	40.00–50.00
Apr. 3, 1916	40.00–50.00
July 3, 1916	40.00–50.00
Oct. 2, 1916	40.00–50.00
Jan. 1, 1917	40.00–50.00
July 2, 1917	40.00–50.00
Oct. 1, 1917	(15)
KAINITE (MINIMUM, 12.4 PER CENT K_2O IN BULK).	
[Per ton, New York, spot.]	
Jan. 1, 1912	8.25
Apr. 1, 1912	8.25
July 1, 1912	8.45
Sept. 30, 1912	8.45
Dec. 30, 1912	8.45
Mar. 31, 1913	8.45
June 30, 1913	8.45
Sept. 29, 1913	8.45

	Prices.
KAINITE (MINIMUM, 12.4 PER CENT K_2O IN BULK)—Contd.	
Dec. 29, 1913	$8.45
Mar. 28, 1914	8.36
June 29, 1914	8.36
Sept. 28, 1914	8.56
Dec. 28, 1914	8.56
Sept. 27, 1915	$40.00–50.00
Jan. 3, 1916	40.00–50.00
Apr. 3, 1916	40.00–50.00
July 3, 1916	40.00–50.00
Oct. 2, 1916	40.00–50.00
Jan. 1, 1917	40.00–50.00
July 2, 1917	40.00–50.00
Oct. 1, 1917	(15)
SALTPETER, CRUDE.[16]	
[Per pound, New York, spot.]	
Jan. 1, 1912	.04½–.05
Apr. 1, 1912	.04½–.05
July 1, 1912	.04½–.05
Sept. 30, 1912	.05
Dec. 30, 1912	.05
Mar. 31, 1913	.05
June 30, 1913	.05
Sept. 29, 1913	.04½–.04¾
Dec. 29, 1913	.04½–.04¾
Mar. 30, 1914	.04¾–.05
June 29, 1914	.04¾–.05
SALTPETER, REFINED.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.04¾–.06
Apr. 1, 1912	.04¾–.06
July 1, 1912	.05 –.06½
Sept. 30, 1912	.05 –.06½
Dec. 30, 1912	.05½–.06½
Mar. 31, 1913	.05½–.06½
June 30, 1913	.05½–.06½
Sept. 29, 1913	.05½–.06½
Dec. 29, 1913	.05½–.06½
Mar. 30, 1914	.04¾–.05½
June 29, 1914	.04¾–.05½
Sept. 28, 1914	.09 –.10
Dec. 28, 1914	.07 –.08
Mar. 29, 1915	.09¾–.10¾
June 28, 1915	.15½–.16½
Sept. 27, 1915	.18 –.19
Jan. 3, 1916	.35 –.38
Apr. 3, 1916	.35 –.38
July 3, 1916	.29¾–.30¾
Oct. 2, 1916	.28 –.30
Jan. 1, 1917	.31 –.35
Apr. 2, 1917	.31 –.38
July 2, 1917	.31 –.38
Dec. 31, 1917	(17)
Apr. 8, 1918	.31 –.31½
July, 1918	.31 –.31½
October, 1918	.31 –.31½
January, 1919	.31 –.31½
April, 1919	.21 –.25½
July, 1919	.16 –.16½
October, 1919	.14½–.16
January, 1920	.14½–.16½
April, 1920	.14½–.16½

[14] In bags.
[15] Nominal from October, 1917, to April, 1920.
[16] Not listed since 1914.
[17] Not listed.

Rates of duty on individual salts.

POTASH, BICARBONATE OF, REFINED.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	73	Potash, bicarbonate of, or supercarbonate of, and saleratus, calcined or pearl-ash	1½ cents per pound.
1890	76	All chemical compounds and salts, n. s. p. f.	25 per cent ad valorem.
1894	60	....do	Do.
1897	3	....do	Do.
1909	3	All chemical compounds, mixtures, and salts, n. s. p. f.	Do.
1913	64	Potash, bicarbonate of, refined	½ cent per pound.

POTASH, CARBONATE OF, CRUDE (OR BLACK SALTS).

1883	63	Potash: crude, carbonate of, or fused	20 per cent ad valorem.
1890	685	Potash, crude, carbonate of, or "black salts"	Free.
1894	595	....do.[1]	Do.
1897	644	Potash, crude, or "black salts"; carbonate of potash, crude or refined.	Do.
1909	655	....do	Do.
1913	580	Potash, crude, or "black salts"; carbonate of	Do.

POTASH, CHLORATE OF.

1883	64	Potash, chlorate of	3 cents per pound.
1890	685	Chlorate of potash	Free.
1894	595	....do	Do.
1897	63	Potash, chlorate of	2½ cents per pound.
1909	61	Chlorate of potash	2 cents per pound.
1913	64	Potash, chlorate of	½ cent per pound.

POTASH, CHROMATE AND BICHROMATE OF.

1883	48	Chromate of potash	3 cents per pound.
	49	Bichromate of potash	Do.
1890	69	Potash, bichromate and chromate of	Do.
1894	54	....do	25 per cent ad valorem.
1897	62	....do	3 cents per pound.
1909	60	....do	2½ cents per pound.
1913	64	Potash, chromate and bichromate of	1 cent per pound.

POTASH, CYANIDE OF.

1883	92	All chemical compounds and salts, by whatever name known, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	76	All chemical compounds and salts, n. s. p. f.	Do.
1894	60	....do	Do.
1897	66	Cyanide of potassium	12½ per cent ad valorem.
1909	64	....do	Do.
1913	580	Potash, cyanide of	Free.

POTASH, HYDRATE OF.

1883	63	Caustic potash (no specific provision for hydrate of potash).	20 per cent ad valorem.
1890	70	Potash, caustic or hydrate of, refined, in sticks or rolls	1 cent per pound.
	685	Caustic potash, or hydrate of, not including refined, in sticks or rolls.	Free.
1894	595	Caustic potash, or hydrate of, including refined, in sticks or rolls.	Do.
1897	63	Potash, caustic or hydrate of, refined, in sticks or rolls	1 cent per pound.
	644	Potash, hydrate of, or caustic potash, not including refined, in sticks or rolls.	Free.
1909	61	Caustic, or hydrate of potash, refined, in sticks or rolls	1 cent per pound.
	655	Potash, hydrate of, or caustic potash, not including refined, in sticks or rolls. Where there is less than 50 per cent of caustic potash or more than 10 per cent of soda, dutiable as chemical mixture or combination of alkalies under paragraph 3. (Dept. Order, T. D. 32440.)	Free.
1913	580	Potash, hydrate of, when not containing more than 15 per cent of caustic soda.	Do.
	5	Potash, hydrate of, when containing more than 15 per cent of caustic soda is not specifically provided for and falls within paragraph 5 for chemical compounds or salts, n. s. p. f.	15 per cent ad valorem.

[1] Carbonate of potash was held under the act of 1894 to include both the impure and refined. (T. D. 17430, G. A. 3604; 19067, G. A. 4087; following United States v. Giese, 83 Fed., 692.)

Rates of duty on individual salts—Continued.

POTASH, HYDRIODATE OF.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	65	Potash, hydriodate	50 cents a pound.
1890	71	do	Do.
1894	55	do	25 cents a pound.
1897	64	do	Do.
1909	62	do	Do.
1913	5	All chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof, n. s. p. f.	15 per cent ad valorem.

POTASH, IODATE OF.

1883	65	Potash, iodate	50 cents per pound.
1890	71	do	Do.
1894	55	do	25 cents per pound.
1897	64	do	Do.
1909	62	do	Do.
1913	5	All chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof, n. s. p. f.	15 per cent ad valorem.

POTASSIUM IODIDE.

1883	65	Potash, iodide	50 cents per pound.
1890	71	do	Do.
1894	55	do	25 cents per pound.
1897	64	do	Do.
1909	62	do	Do.
1913	38	Potassium iodide	15 cents per pound.

POTASH, MURIATE OF.

1883	627	Potash, muriate of	Free.
1890	685	Muriate of potash	Do.
1894	595	do	Do.
1897	644	do	Do.
1909	655	do	Do.
1913	580	Potash, muriate of	Do.

POTASH, NITRATE OF, CRUDE.

1883	68	Potash, nitrate of, or saltpeter, crude	1 cent per pound.
1890	685	Nitrate of potash, or saltpeter, crude	Free.
1894	595	do	Do.
1897	644	do	Do.
1909	655	do	Do.
1913	580	Potash, nitrate of, or saltpeter, crude	Do.

POTASH, NITRATE OF, REFINED.

1883	69	Potash, nitrate of, or refined saltpeter	1½ cents per pound.
1890	72	Potash, nitrate of, or saltpeter, refined	1 cent per pound.
1894	56	do	½ cent per pound.
1897	65	do	Do.
1909	63	Nitrate of potash, or saltpeter, refined	Do.
1913	64	Potash, nitrate of, or saltpeter, refined	$7 per ton.

POTASH, PERMANGANATE OF.

1883	92	All chemical compounds and salts, by whatever name known and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	76	All chemical compounds and salts, n. s. p. f.	Do.
1894	60	do	Do.
1897	3	do	Do.
1909	3	All chemical compounds, mixtures, and salts, n. s. p. f.	Do.
1913	64	Potash, permanganate of	1 cent per pound.

Rates of duty on individual salts—Continued.

POTASH, PRUSSIATE OF, RED.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	66	Potash, prussiate of, red	10 cents per pound.
1890	73	do	Do.
1894	57	do	25 per cent ad valorem.
1897	66	do	5 cents per pound.
1909	64	do	Do.
1913	64	do	2 cents per pound.

POTASH, PRUSSIATE OF, YELLOW.

1883	67	Potash, prussiate of, yellow	5 cents per pound.
1890	73	do	Do.
1894	57	do	25 per cent ad valorem.
1897	66	do	4 cents per pound.
1909	64	do	Do.
1913	64	do	1½ cents per pound.

POTASH, SULPHATE OF.

1883	70	Potash, sulphate of	20 per cent ad valorem.
1890	685	Sulphate of potash, crude or refined	Free.
1894	595	do	Do.
1897	644	do	Do.
1909	655	do	Do.
1913	580	Potash, sulphate of	Do.

TARTRATE OF SODA AND POTASSA AND ROCHELLE SALTS.

1883	29	Soda and potassa tartrate, or Rochelle salts	3 cents per pound.
1890	92	Tartrate of soda and potassa, or Rochelle salts	Do.
1894	75	do	2 cents per pound.
1897	6	do	4 cents per pound.
		Containing more than 90 per cent of bitartrate of potash	5 cents per pound.
1909	6	Tartrate of soda and potassa, or Rochelle salts	3 cents per pound.
		Containing more than 90 per cent of bitartrate of potash	4 cents per pound.
1913	8	Rochelle salts, or tartrate of soda and potassa	2½ cents per pound.

KELP.

1883	540	Kelp	Free.
1890	623	do	Do.
1894	524	do	Do.
1897	589	do	Do.
1909	601	do	Do.
1913	523	do	Do.

KAINITE.

1883	616	Kyanite or cyanite, and kainite	Free.
1890	625	do	Do.
1894	526	do	Do.
1897	591	do	Do.
1909	604	do	Do.
1913	525	do	Do.

COURT AND TREASURY DECISIONS.

PERMANGANATE OF POTASH.

Permanganate of potassa, used almost exclusively as a disinfectant, was held dutiable under the provision in the act of 1861 for "all other salts and preparations of salts n. o. p. f." (Dept. Order, T. D. 1545.)

POTASSIUM.

Merchandise described as "the elementary substance known as potassium, the metallic base of potash," was held dutiable as "metal, unwrought." (Appeal of Contanseau Rapid Foreign Express Co., T. D. 9324.)

CYANIDE OF POTASSIUM.

Cyanide of potassium was held dutiable as a chemical salt not derived from coal tar under paragraph 60 of the act of 1894, and not exempt from duty as a coal-tar product or preparation under paragraph 443. (G. A. 3681, T. D. 17633.)

A mixture of cyanide of potassium and cyanide of sodium, known commercially as cyanide of potassium, was held dutiable as cyanide of potassium under paragraph 66 of the act of 1897, and not as a chemical salt, the provision being construed as not limited to the pure potassium cyanide. (G. A. 4777, T. D. 22521.)

This decision was followed under the act of 1909, notwithstanding the Government's contention that paragraph 3 of that act applied only to the pure cyanide of potassium used in medicine, as by virtue of the pure-food law the impure article is not permitted to be labeled or sold as cyanide of potassium. (Abstract 23365, T. D. 30645, followed in Abstract 23593, T. D. 30733; Abstract 24026, T. D. 30969; Abstract 24475, T. D. 31165; Abstract 24568, T. D. 31207; Abstract 27170, T. D. 32031; Abstract 30514, T. D. 32943; but not in Abstract 35678, T. D. 34468.)

An article containing 22 per cent of cyanide of potassium, 57 per cent of cyanide of sodium, and 21 per cent of other substances was held on the testimony to be commercially cyanide of potassium within paragraph 64 of the act of 1909, and therefore dutiable at 12½ per cent ad valorem and not at 25 per cent under paragraph 3 as a chemical compound, mixture, or salt. (Abstract 29723, T. D. 32823; Abstract 30109, T. D. 32858; G. A. 7571, T. D. 34495; Abstract 36943, T. D. 34933.)

But a substance composed of 10 per cent cyanide of potash and the remainder cyanide of soda, classified as a chemical compound, was held not dutiable as cyanide of potassium. (Abstract 36046, T. D. 34609.)

G. A. 7571, T. D. 34495, supra, was also followed under the act of 1913. (Abstract 37164.)

CARBONATE OF POTASH.

An article consisting of carbonate, sulphate, and chloride of potassa, together with insoluble matter, containing more than 30 per cent of free potash and constituting the crude carbonate of potash, was held to be different from the black salts of commerce, which was declared to be the crude caustic potash from which the carbonate of

potash is made by one process, whereas the caustic potash of commerce is made by another process. Classification was made under the Revised Statutes as an unenumerated manufactured article. (Dept. Order, T. D. 5096.)

Merchandise described as "a species of crude potash" was held dutiable under the act of 1883 as "potash, crude," and not exempt under the provision for "aniline salts or black salts and black tares," not being known in commerce as black salts and admittedly not an aniline salt. (Appeal, T. D. 8601.)

Carbonate of potash, crude, somewhat advanced toward the condition of pearlash and not so crude or dark colored as black salts, was held exempt from duty as crude carbonate of potash under the act of 1890 and not dutiable as refined. (G. A. 1249, T. D. 12565.)

Refined carbonate of potash was held exempt from duty under the provision in paragraph 595 of the act of 1894 for "potash, crude, carbonate of, or 'black salts,'" and not dutiable as a chemical salt. The Government contended that the word "crude" in paragraph 595 qualified the phrase "carbonate of, or 'black salts,'" and that the phrase "potash, crude, carbonate of, or 'black salts'" covered only one product. The Board of General Appraisers held that the said terms should be applied distributively so as to provide for crude potash, carbonate of potash, and black salts. Its view was sustained by the Circuit Court for the Southern District of New York and by the Circuit Court of Appeals for the Second Circuit. (Dept. Order, T. D. 17380, 17381; G. A. 3604, T. D. 17430; U. S. *v.* Giese, 78 Fed., 805, T. D. 17900; 83 Fed., 692, T. D. 18810; G. A. 4087, T. D. 19067, overruling T. D. 17027.)

BICARBONATE OF POTASH.

Bicarbonate of potash was held dutiable under the Revised Statutes as a medicinal preparation. (Dept. Order, T. D. 4117.)

Bicarbonate of potash was held dutiable as a chemical salt under paragraph 76 of the act of 1890. (G. A. 548, T. D. 11189.)

CAUSTIC POTASH.

Caustic potash, or hydrate of potash, was held not to assimilate in character and use to pearl-ash and to be dutiable as an unenumerated article under the Revised Statutes. (Dept. Order, T. D. 3940. Compare T. D. 420, holding calcined potash or hydrate of potash similar in character and use to pearlash and dutiable accordingly.)

So-called caustic potash, containing less than 50 per cent of caustic potash or more than 10 per cent of soda, was held dutiable under the act of 1909 as a chemical mixture or a combination of alkalies and not exempt from duty as caustic potash. (Dept. Order, T. D. 32440.)

Caustic potash may vary in purity from 40 to 98 per cent. An article showing by chemical analysis the presence of 39.85 per cent caustic potash was held to be the commercial article sold under that name and entitled to free entry under paragraph 655 of the act of 1909. (G. A. 7468, T. D. 33509.)

NITRATE OF POTASH OR SALTPETER.

Under the law providing separately for nitrate of potash, crude, partially refined, and refined, saltpeter was held dutiable as partially refined only when actual process of refinement had taken place since the first crystallization. Otherwise than in that form the article was classified as crude or as refined according to its condition. (T. D. 674 of 1870.)

SULPHATE OF POTASH.

Sulphate of potash, the only common use of which, either by itself or in combination with other materials, is as a manure or in the manufacture of manure, was held exempt from duty under the act of 1883 as a substance expressly used for manure and not dutiable as sulphate of potash. (Magone *v.* Heller, 150 U. S., 70, remanding 38 Fed., 908; Dept. Order, T. D. 17718.)

All substances, whether provided for by name or otherwise, which serve to enrich the soil were held to come within the provision in that act for substances expressly used for manure. (Schultz *v.* Cadwalader, 43 Fed., 290.)

BISULPHITE OF POTASH.

Bisulphite of potash, classified by the collector as a chemical salt, was held to be a combination of an acid and an alkali base and not caustic or hydrate of potash, and hence not exempt from duty under the provision for "caustic potash, or hydrate of, not including refined, in sticks or rolls," in the act of 1890. (G. A. 496, T. D. 11053.)

POTASH WATER.

Potash water, an artificial mineral water, was held not exempt from duty under the act of 1894 as similar to lemonade and soda water. (G. A. 3619, T. D. 17480.)

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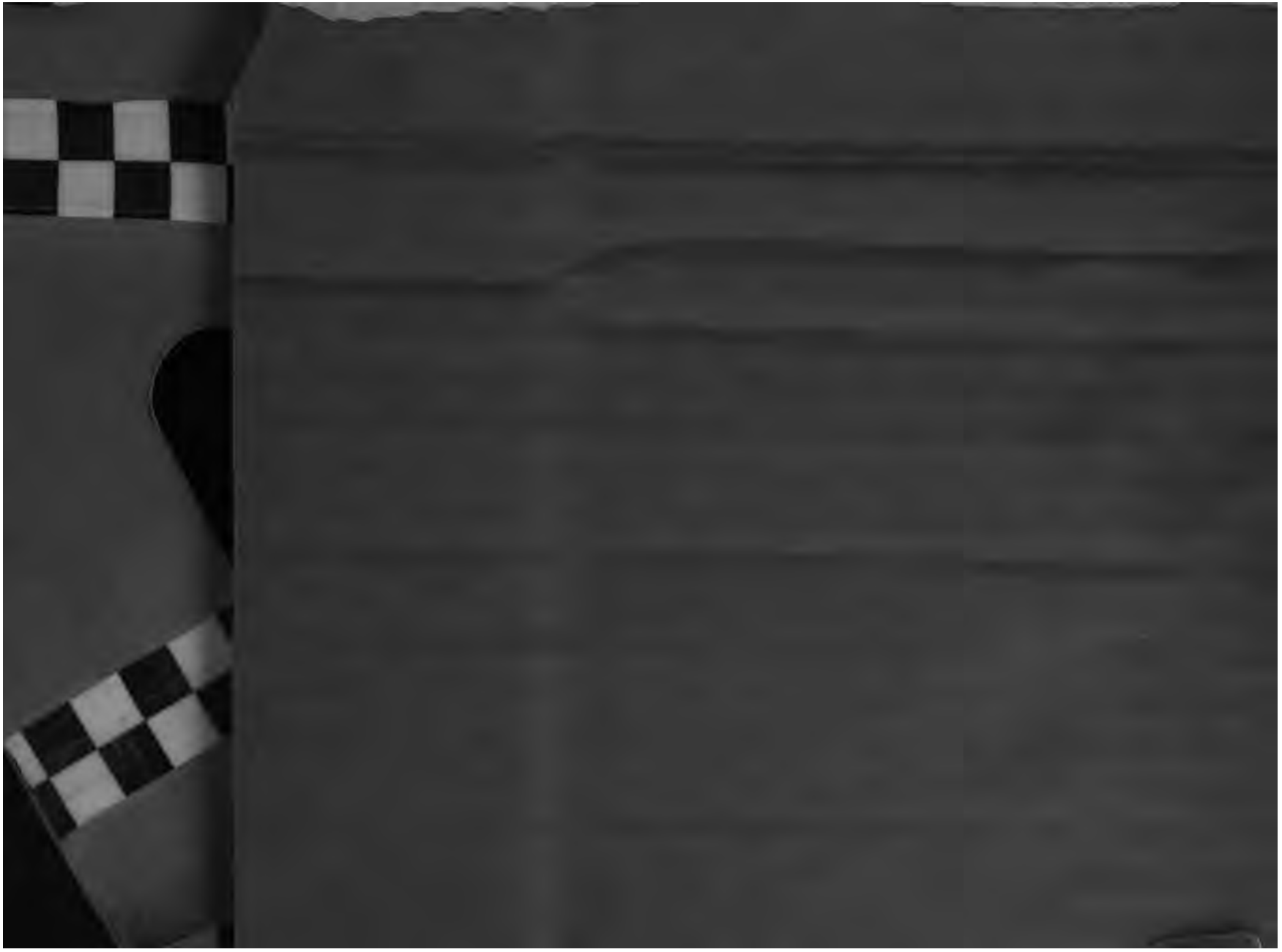

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 11, 12, 13, 14, 15, 16, AND 17 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

Paragraph 5:
Liquid Chlorine n. s. p. f.

Paragraph 11:
Blacking, Cleaning, and Polishing Preparations

Paragraph 12:
Bleaching Powder

Paragraph 13:
Caffeine and Compounds
Tea Waste, etc.

Paragraph 14:
Calomel
Corrosive Sublimate
Other Mercurials

Paragraph 15:
Chalk and Manufactures

Paragraph 16:
Alcoholic Preparations

Paragraph 17:
Small Package Articles

Paragraph 60:
Whiting and Paris White

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Gift
U.S. Tariff Comm.
6-4-29

PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

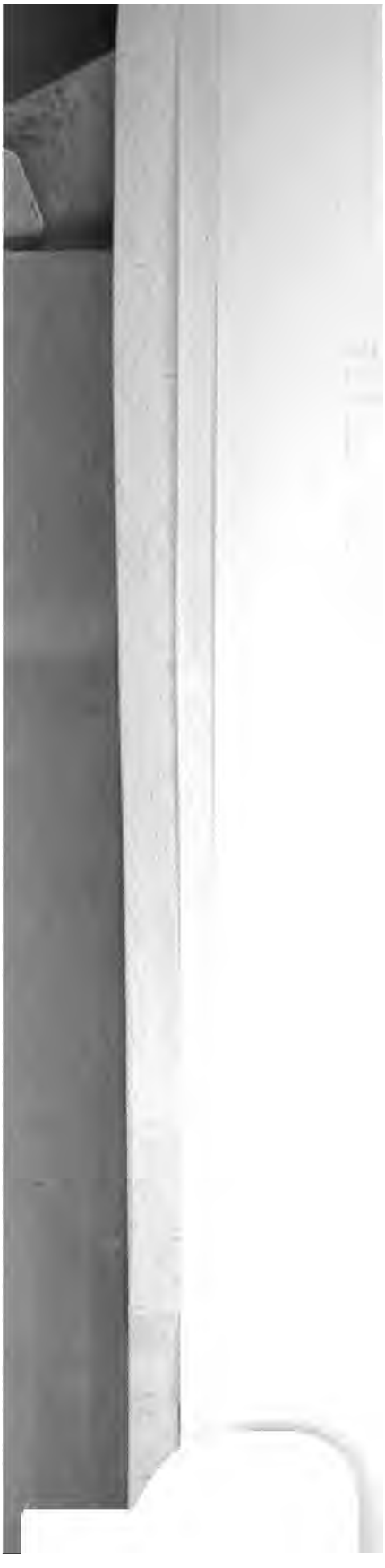
In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus by use of this "Introduction and Index," the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Dr. Grinnell Jones, C. R. DeLong, Sidney D. Kirkpatrick, and E. E. Stanford, of the chemical division of the commission's staff, and of others.



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BLACKING, CLEANING, AND POLISHING PREPARATIONS.

[Par. 11, act of 1913, 15 per cent ad valorem.]

GENERAL INFORMATION.

Description and uses.—This paragraph covers all articles used as blacking, polishes, and cleaning preparations, such as shoe blacking, leather polishes, stove polishes, floor polishes, furniture polishes, auto body polishes, metal polishes, and scouring compounds used for cleaning, and wall-paper cleaners.

Production of blacking, stains, and dressings in 1914 was valued at $10,259,617; of polishing preparations, $5,228,178; and of cleaning preparations, $5,565,846.

Blacking and all creams and preparations for cleaning or polishing boots and shoes, not containing alcohol—Imports for consumption—Revenue.

BLANCO POLISH.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:						*Per cent.*
1908	20 per cent		$3,983	$796		20.00
1909	do		5,687	1,137		20.00
1910	do		1,539	307		20.00
	25 per cent		4,855	1,213		25.00
1911	do		14,948	3,737		25.00
1912	do		34,912	8,728		25.00
1913	do		21,854	5,463		25.00
1914	do		6,145	1,536		25.00
	15 per cent		11,852	1,777		15.00
1915	do		17,743	2,661		15.00
1916	do		21,229	3,184		15.00
1917	do		53,458	8,018		15.00
1918	do		24,821	3,723		15.00
Calendar years:						
1918			21,893	3,284		15.00
1919			22,089	3,313		15.00

ALL OTHER.

Fiscal years:						*Per cent.*
1908	25 per cent		$21,626	$5,406		25.00
1909	do		22,449	5,612		25.00
1910	do		35,171	8,792		25.00
1911	do		44,952	11,238		25.00
1912	do		41,764	10,441		25.00
1913	do		40,106	10,026		25.00
1914	do		5,488	1,372		25.00
	15 per cent		18,174	2,726		15.00
1915	do		17,161	2,574		15.00
1916	do		22,334	3,350		15.00
1917	do		36,649	5,497		15.00
1918	do		26,724	4,008		15.00
Calendar years:						
1918			28,186	4,228		15.00
1919			39,025	5,854		15.00

Blacking, cleaning, and polishing preparations—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883.....	397	Blacking of all kinds.....	25 per cent ad valorem.
	479	Polishing powders of every description, by whatever name known, including Frankfort black * * *.	20 per cent ad valorem.
1890.....	11	Blacking of all kinds.....	25 per cent ad valorem.
1894.....	9	.....do.....	20 per cent ad valorem.
1897.....	7	.....do.....	25 per cent ad valorem.
1909.....	7	Blacking of all kinds; all creams and preparations for cleaning or polishing boots and shoes.	Do.
1913.....	11	Blacking of all kinds, polishing powders, and all creams and preparations for cleaning or polishing, not specially provided for in this section. *Provided*, That no preparations containing alcohol shall be classified for duty under this paragraph.	15 per cent ad valorem.

COURT AND TREASURY DECISIONS.

"Blacking of all kinds" in the act of 1897 included all forms of shoe polish, among them White Cream. (G. A. 4154, T. D. 19415, of 1898.) Nevertheless, a specific provision for "all creams and preparations for cleaning or polishing boots and shoes" was added in 1909. "Blanco" was held to come within this provision. (Abstract 24875, T. D. 31335, of 1911.) Removal in 1913 of the restriction to boots and shoes rendered unnecessary the enumeration of polishing powders. To come within paragraph 11, the cream, preparation, or powder must have been prepared or imported for cleaning or polishing in the condition in which it is imported. Wrought earth for use in the manufacture of polishing creams and polishing pastes are dutiable under paragraph 76. (G. A. 7594, T. D. 34697, of 1914.) Both paste and liquid polish are included. (Abstract 41858, of 1918.)

BLEACHING POWDER OR CHLORIDE OF LIME.

[Par. 12, act of 1913, one-tenth cent per pound.]

SUMMARY.

Description.—Bleaching powder or chloride of lime is a white powder which evolves chlorine when treated with an acid. It is sold on a basis of the "available chlorine" content. Bleaching powder, in spite of many disadvantages, has been the best means of shipping chlorine until within recent years when liquid chlorine was introduced. As its name indicates, it is primarily a bleaching agent. It is used for bleaching pulp and paper stock, cotton and linen in textile mills and laundries, and for the purification of public water supplies.

Domestic production.—The production of bleaching powder in 1914 amounted to 310,380,000 pounds valued at $2,916,225. This quantity was nearly twice the production in 1909. There has been no census of production since 1914. The United States at the present time (1920) supplies its own consumption of bleaching powder. During the fiscal year 1918 there was exported 13,060,401 pounds of bleaching powder valued at $558,066.

The manufacture of bleaching powder, on a commercial scale, was established in this country during 1897 after the passage of the act of 1897 which placed a duty of one-fifth cent per pound on the article. From this time on the industry developed rapidly, soon supplying the greater part of our own needs. Since 1915 the imports have been negligible.

The materials necessary for the production of bleaching powder are lime and chlorine gas. The chlorine gas is a joint product in the manufacture of electrolytic caustic soda.

A large part of the bleaching powder is made at Niagara Falls, N. Y. It is also produced by two firms in Michigan and one firm in California.

There is a marked tendency for the larger consumers of bleaching powder to install electrolytic chlorine plants and produce their own bleach in liquid form.

Foreign production.—The largest producers of bleaching powder before the war were the United States, United Kingdom, and Germany. At the present time (1920) it seems safe to say that this country is manufacturing as much if not more bleaching powder than any other country.

Imports.—Previous to 1914 we imported between 40,000 and 60,000 short tons of bleaching powder. Between 70 and 80 per cent of this came from the United Kingdom, and most of the remainder from Germany. Since 1914 the imports have fallen off until in 1918 only 2 tons were imported.

Prices.—Before the war bleaching powder sold at a constant price of about $25 per ton. During 1916 it was quoted as high as $240 per ton. At the beginning of 1918 the price had declined to about $50 per ton.

Tariff history.—Bleaching powder was free of duty until the passage of the act of 1897 when it was made dutiable at one-fifth cent per pound. This duty was reduced to one-tenth cent per pound by the act of 1913.

Bleaching powder (chloride of lime)—Summary table.

	Domestic production.	Imports for consumption.	Domestic exports.[1]
Fiscal years:	*Pounds.*	*Pounds.*	*Pounds.*
1910	116,802,000	93,838,195	
1911		99,478,125	
1912		72,706,732	
1913		76,092,127	
1914	310,380,000	48,497,239	
1915		18,402,130	
1916		3,289,790	
1917		65,564	
1918		535	13,060,401
1919		539,496	15,640,089
Calendar years:			
1918		540,131	9,450,793
1919		341,812	21,019,736
1920[2]		488,395	20,248,576

	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate.
Fiscal years:				*Per cent.*
1910	$750,140.00	$187,676.00	$0.008	25.02
1911	802,015.00	198,957.00	.008	24.81
1912	600,621.00	145,413.00	.008	24.21
1913	619,492.00	152,184.00	.008	24.57
1914	416,898.00	59,237.00	.0085	14.21
1915	197,975.00	18,402.00	.0107	9.30
1916	80,418.00	3,290.00	.024	4.09
1917	3,888.00	66.00	.059	1.69
1918	83.00	.54	.155	.64
1919	11,363.00	540.00	.021	4.75
Calendar years:				
1918	11,446.00	540.00	.021	4.72
1919	6,787.00	341.00	.019	5.04
1920[2]	6,834.00	488.00	.014	7.14

[1] Not shown in Commerce and Navigation of the United States prior to the 1918 fiscal year.
[2] First 6 months of calendar year 1920.

General Information.

Description.—Bleaching powder is also called, in commerce, chloride of lime. In scientific nomenclature it may be regarded as a double salt of calcium chloride and calcium hypochlorite mixed with 2 to 5 per cent excess of slaked lime and a little water. The chemical formula is generally conceded to be CaClOCl. When it is dissolved in water it forms a solution of calcium chloride and calcium hypochlorite.

It is a white powder which readily evolves chlorine when treated with an acid. Bleaching powder absorbs moisture and carbon dioxide from the air which results in deterioration and decomposition of the product. It must, therefore, be shipped in air-tight containers, such as sheet-iron drums or wooden barrels painted with asphalt paint. Even with these precautions it deteriorates slowly in storehouses; and the shaking during shipment causes more rapid deterioration. Hence the strength of bleaching powder is nearly

always guaranteed only at the place of shipment. Lunge [1] states that bleach shipped with 35 per cent available chlorine in England should show at least 32 per cent at Hamburg or New York. It is a mistake to demand a high-test bleach for export shipment, as a high-test bleach deteriorates faster than a low-test bleach. In order to reduce the deterioration to a minimum, the bleaching powder should contain 2 to 5 per cent excess of lime. In spite of the fact that bleaching powder contains a low per cent of chlorine (the active constituent) and that it deteriorates during storage and shipment it has been the best means of shipping chlorine until within recent years, when liquid chlorine shipped in steel cylinders became a rival of bleaching powder. It is doubtful whether liquid chlorine will replace bleaching powder in export trade on account of the back shipment of the empty cylinders.

The grade of any product of bleaching powder is determined by its percentage content of available chlorine. Practically all bleaching powder contains at least 30 per cent, and is sold on a basis of "35 per cent of available chlorine." That is, all price quotations on bleaching powder refer to a product containing 35 per cent of chlorine, and contract prices are usually made on a sliding scale basis for an article which, on analysis, shows a greater or less per cent of chlorine.

Raw materials.—The materials necessary for the manufacture of bleaching powder are lime and chlorine gas. Lime is produced by burning limestone. The lime should be well calcined, and should contain over 95 per cent of lime (CaO), but little magnesia, carbonic acid, iron, and insoluble material, such as clay and sand. The chlorine which enters into the manufacture of bleaching powder, in this country, is all produced by passing a direct current of electricity through a solution of common salt. This method, known as the "electrolytic process," produces chlorine gas of a high concentration and purity.

The production of bleaching powder, then, is dependent on the basic raw materials, salt and limestone, both of which are available in large quantities in this country. The production of bleaching powder requires considerable electrical power, but the cost of electrical power is not so vital to this industry as to most other electrochemical processes, and it has been possible to operate plants dependent on steam power.

Process of manufacture.—Quicklime, of a suitable purity, is slaked by slowly adding water until the resulting product contains between 2 and 5 per cent excess of water. The slaked lime is sifted to remove all lumps and then should be allowed to cool, protected from the air. For the absorption of the chlorine, the lime is piled on the floor of chambers to a depth varying from 1 inch to 8 inches. In the one chamber process bleaching powder can be made without turning the lime, if the depth does not exceed 2 inches. The three-chamber process, which is more or less a continuous one and operates on the counter-current principle, permits the lime to be piled 8 inches deep. This system is preferable, as it absorbs the chlorine completely and prevents leakage of chlorine, a common occurrence in the one-chamber process. The chlorine is admitted slowly to the chambers until the

[1] Lunge. Sulphuric acid and alkali. Vol. 3, p. 643.

lime is completely chlorinated. The temperature of the lime during chlorination should be kept below 45° C. It is possible to make a stronger bleaching powder during cold weather than in warm weather. After chlorination the powder is packed in drums or wooden barrels for shipment. In France it is the custom to sift the bleaching powder before packing. During this operation the bleach loses in strength, but the resulting product will keep longer and is much better for shipment. The yield of bleaching powder obtained is, in good practice, one and a half times the quantity of lime used.

Hasenclever, an English chemist, overcame serious engineering difficulties in building an apparatus for carrying out this process in a continuous manner. His apparatus is, in essentials, a series of continuous conveyors; the lime is fed into the top while the chlorine is drawn in at the bottom in a direction opposite to the lime. We have no knowledge that this process is being used in the United States.

The foreign and domestic methods of manufacture are not dissimilar, the primary difference being the method used in the production of the chlorine. In England and France the Deacon and Weldon processes have been generally used, although recently the electrolytic process has gained considerable headway. Both of these processes obtain chlorine by the oxidation of hydrochloric acid, which has been produced from salt. The Deacon process oxidizes the hydrochloric acid by means of air, while the Weldon process uses manganese dioxide which is regenerated and used again. Both are more complicated than the electrolytic process. In Germany the chlorine is obtained from the electrolysis of solutions of sodium or potassium chlorides.

Skilled labor in the manufacturing of bleaching powder is not a necessity so long as the plant is under the supervision of a competent chemist.

Since the manufacture of bleaching powder in this country is dependent on electricity for the production of chlorine, it naturally follows that Niagara Falls should be a center for this industry. However, it is not confined to this locality, as plants in other parts of the country have been operated successfully on electricity generated from steam power.

Important uses.—Bleaching powder, as its name indicates, is essentially a bleaching agent. It is used for the bleaching of wood pulp and other paper stocks, cotton and linen fabrics, cotton for the manufacture of gun cotton, and as a bleaching agent in laundries. It is also used in the manufacture of other chemicals, principally chloroform; for the purification of public water supplies; and as a disinfectant, deodorant and germicide. For domestic uses it is sold in small tin cans under the name of chloride of lime.

Substitutes and rival commodities.—(*a*) Liquid bleach: This is a solution of calcium hypochlorite and chloride produced by passing chlorine into a solution of lime, commonly called "milk of lime." It is easier to make than bleaching powder and is usually produced at the place where it is to be consumed. The numerous paper and pulp mills in this country which make their own bleach furnish instances of this practice. There is a marked tendency for the large consumers of bleaching powder to install electrolytic chlorine plants and to produce their own bleach in liquid form. This tendency has been accentuated by the war demands on chlorine.

(*b*) Liquid chlorine: Since about 1910 this article has become a rival of bleaching powder and is fast displacing it in the purification of water supplies. It is also being used for bleaching in textile mills. It is doubtful whether liquid chlorine will take the place of bleaching powder for export, owing to the necessary back shipment of the containers.

(*c*) Hypochlorites of sodium and potassium: Owing to the high cost of potassium salts, the hypochlorite of sodium is usually made in this country. It is produced by a special electrolytic cell at the place of consumption, or it is made from bleaching powder by treatment with soda ash. Sodium hypochlorite is preferred to lime bleach in the bleaching of cotton and linen because it gives a clear solution and because the salts formed during the bleaching are easily removed from the fabric by washing. For this reason it is used extensively in laundries and textile mills.

History of the industry.—Bleaching powder was invented in 1799 by Tennant, an Englishman. It was first made in the same year by the St. Rollox Works (England) and sold at £140 (about $700) per ton. The early development of the manufacture of this commercial product took place in England. It was not until 1897, however, after the passage of the tariff act of 1897, which placed a duty of one-fifth cent per pound on bleaching powder, that its manufacture was undertaken on a commercial scale in the United States. The plant of the Dow Chemical Co. at Midland, Mich., and of the Castner Electrolytic Alkali Co., at Niagara Falls, N. Y., were both started in the latter part of 1897.

The industry developed rapidly from that time on. As shown by the Census of Manufactures, the production increased from 21,958,000 pounds valued at $462,949 in 1899 to 310,380,000 pounds valued at $2,916,225 in 1914. As the American industry expanded to meet our own demands, there was a gradual decline in imports. Not until about 1908, however, was there a marked falling off in imports. This probably was due to an increase in consumption with imported bleaching powder about holding its own. Just prior to the outbreak of the war the imports of bleaching powder had fallen off 30,000,000 to 40,000,000 pounds; they have since become negligible. During the 1918 fiscal year only 4,285 pounds were imported. The importation of bleaching powder was restricted by the Shipping Board and the War Industries Board. The reason for this restriction was that Europe was the only source of imports and we were then shipping large quantities of bleaching powder and other chlorine products to Europe. Therefore, importation of bleaching powder from Europe was a waste of shipping space. The fact that we are now supplying our own consumption, and that during the 1918 fiscal year we exported over 13,000,000 pounds is sufficient indication of the development of the bleaching powder industry in the United States.

Largest producers.—Although figures on the actual production of bleaching powder in the United Kingdom and Germany are not available, it is evident that these two countries along with the United States are the largest producers of bleaching powder. The import statistics show that 70 to 80 per cent of the bleaching powder imported into the United States came from the United Kingdom and the greater part of the remainder from Germany. The following

table compiled from official publications of Germany[1] and the United Kingdom [2] is indicative of the status of the industry in these countries:

Exports of bleaching powder.

Year.	United Kingdom.		Germany.[1]	
	Short tons.	Value.	Short tons.	Value.
1909	51,016	$950,033	31,453	$736,848
1910	56,412	1,024,189	28,734	683,060
1911	51,165	947,858	32,186	961,044
1912	46,254	875,279	35,554	1,170,246
1913	40,678	820,725	40,204	1,284,962
1914	33,561	772,679	.....	.....
1915	27,510	880,501	.....	.....
1916	9,693	694,245	.....	.....

[1] Includes bleaching powder, bleaching lyes, and peroxides of hydrogen and barium.

Lunge[3] states that the production of bleaching powder in England was 125,000 tons in 1909 with the production decreasing. The production in the United States in 1914 was 150,000 tons. This information seems to indicate that at this time the United States was producing as much bleaching powder as any other country.

The bleaching powder industry expanded greatly during the war as shown by the following table. The exports of this commodity from Japan in 1917 were nearly seven times the prewar exports (1913). Prior to 1916 over 80 per cent of the exports were to China; during 1916 and 1917 British India took over 50 per cent of the exports.

Exports of bleaching powder from Japan.[a]

Country.	1913		1914		1915	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
China	916	$55,102	638	$36,163	1,556	$83,954
Hongkong	180	10,990	123	6,768	184	10,509
British India	(b)	(b)	(b)	(b)	289	20,429
All others	23	1,457	83	4,806	184	11,405
Total	1,119	67,549	844	47,737	2,213	126,297

Country.	1916		1917	
	Short tons.	Value.	Short tons.	Value.
China	1,552	$116,278	1,963	$205,258
Hongkong	382	36,768	494	47,956
British India	3,185	275,216	4,192	439,386
All others	800	61,836	482	47,283
Total	5,919	490,098	7,131	739,883

[a] Compiled from the Annual Return of the Foreign Trade of the Empire of Japan.
[b] Included in all others.
[1] Vierteljahrshefte zur Statistik des Deutschen Reichs.
[2] Annual Statement of the Trade of the United Kingdom.
[3] Lunge: Sulphuric acid and alkali.

Italy,[1] during the years 1909 to 1913, inclusive, produced about 10,000 short tons of bleaching powder per annum. Special Agents Series No. 65, Chemical Industries of Belgium, Netherlands, Norway, and Sweden, by Thomas H. Norton, Bureau of Foreign and Domestic Commerce, contains information on the bleaching-powder situation in these countries. The annual production in Belgium exceeds 6,000 tons. The other three countries are dependent on foreign countries for their supplies.

Competitive Conditions.

Bleaching powder and the electrolytic alkali industry.—Bleaching powder has been one of the chief marketable forms of chlorine gas, which is a joint product of the electrolytic alkali industry, the other product being caustic soda. The electrolytic process necessarily produces caustic soda and chlorine in chemically equivalent amounts, which are approximately equal. The chlorine in turn will produce roughly two and one-half times as much bleaching powder in comparison with the caustic soda produced. On the other hand, the demand for caustic soda is far in excess of the demand for bleaching powder and other chlorine products. Therefore the limit to the amount of caustic soda which can be produced electrolytically is determined by the amount of chlorine (bleaching powder and other products) which can be disposed of.

In an effort to supply a greater portion of the large and profitable market for caustic soda, there has been a tendency on the part of the electrolytic alkali industry to overproduce chlorine or bleach. The result has been that prices for chlorine and bleaching powder have ruled so low that manufacturers claim that there has been very little if any profit in this end of the business. The prewar price of bleaching powder was practically constant at about $25 per ton, making it one of the cheapest chemical products.

Effect of the war on the electrolytic industry.—The war produced a large, although temporary, increase in the demand for chlorine. There are a number of important substances used in poison-gas warfare which require chlorine in their manufacture. Three of these substances which were used in the greatest quantities were chlorine gas itself, phosgene, and mustard gas. Even before the entrance of the United States into the war this demand caused a large increase in the capacity of the existing chlorine plants. The estimated requirements, however, became so great and the prospects of disposing of the increased output when peace came were so small that private concerns were unwilling sufficiently to enlarge their plants on terms acceptable to the Government. The Government, therefore, erected a plant to supply a large part of the increased demand due to our entrance into the war at Edgewood Arsenal, Md. This plant has a capacity of 100 tons of chlorine gas per day.

The output of chlorine during 1918 was about three times the output during 1914. The war undoubtedly caused substantial increased productive capacity in England, France, and Germany.

As a result of this increased capacity to meet war demands, it is expected that keen competition will result. This competition will be sharper in bleaching powder and other chlorine products than in caustic soda.

[1] From Annuario Statistico Italiano.

The war demands for chlorine made it necessary for the Government to control the distribution of all chlorine products, including bleaching powder. In addition, restrictions were placed on the use of bleaching powder by the paper and pulp mills.

Foreign competition.—Germany in the past has interwoven her chlorine industry with her potash industry, which has monopolized the world's markets. Much chloride of potash is treated electrolytically in Germany for the production of caustic potash; the chlorine, which is produced simultaneously, is charged against bleaching powder practically free of cost, since the value of the caustic potash is sufficient to cover all the cost of manufacture of both the caustic potash and chlorine and still leave a large profit. This cheap source of chlorine is largely responsible for the rapid rise of the manufacture of bleaching powder and chlorine products in Germany. Germany, prior to the war, had increased her exports of bleaching materials until they were equal in quantity to the exports of bleaching powder from the United Kingdom.

The firms in England and France which use the Deacon and Weldon processes are apparently at a disadvantage in the production of bleaching powder, since these processes are more complicated and require more attention than the electrolytic process. Although comparative cost figures are not available, the Deacon and Weldon processes appear to be more expensive, since the electrolytic process is gradually being installed in England and France. Since the signing of the armistice marked progress has been made in the establishment of electrolytic chlorine plants in Europe, particularly in France.

Germany and England, prior to the war, controlled the export trade in bleaching powder, while in the United States the industry had developed until we were supplying the larger portion of our consumption. The war forced the immediate withdrawal of Germany and later of England from the export trade in this article. Thus the foreign trade of these two countries was thrown open to the United States. This country, by increased production, has been able to supply its own demands and to develop an export trade. During the fiscal year 1918 we exported some 6,000 short tons of bleaching powder.

With normal competitive conditions restored we may expect a determined effort on the part of England and Germany to regain this trade. This will undoubtedly result in a price-cutting war on the United States trade in this commodity. Our chief advantage in this competition will be our cheap power for electrolysis, but whether this will offset the advantages of cheaper labor in England and the cheap source of chlorine in Germany is a question.

Production of bleaching powder in United States.[1]

["Federal Census."]

Year.	Quantity.	Value.
	Pounds.	
1899	21,958,000	$462,949
1904	39,176,000	535,835
1909	116,802,000	1,786,846
1914	310,380,000	2,916,225

[1] Listed as hypochlorites, chiefly bleaching powder and chloride of lime.

Bleaching powder or chloride of lime—Imports by countries (fiscal years).

Imported from—	1895		1896		1897	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	1,601,208	$28,562	1,373,706	$20,359	2,444,492	$33,914
France	1,436,825	21,026	4,997,277	66,372	9,511,852	117,299
Germany	2,351,637	33,970	4,893,376	64,089	7,914,934	100,428
United Kingdom	94,642,090	1,554,845	92,760,794	1,428,124	79,236,840	1,121,472
All others	425,014	6,432	28,724	414	166,020	2,447
Total	100,456,774	1,644,835	104,053,877	1,579,358	99,274,138	1,375,560

Imported from—	1898 [1]		1898 [2]		1899	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	301,435	$4,102	2,361,516	$29,631	1,780,561	$18,063
France	523,356	7,291	9,850,095	121,234	9,785,182	93,652
Germany	953,757	10,998	11,937,839	130,531	11,166,411	112,127
United Kingdom	4,828,090	68,506	83,262,490	1,048,037	89,723,643	928,767
All others	114,000	1,590	.....	.....	651,453	6,662
Total	6,720,638	92,487	107,511,940	1,329,433	113,107,250	1,159,271

Imported from—	1900		1901		1902	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	3,412,886	$38,414	1,809,660	$23,119	4,741,616	$62,840
France	10,498,455	102,678	6,911,669	76,082	10,437,496	141,980
Germany	18,563,952	177,682	22,414,748	226,846	28,441,862	344,830
United Kingdom	103,482,859	1,140,559	79,824,194	1,044,977	85,717,633	1,226,346
All others	444,999	4,686	252	4	913,089	12,358
Total	136,403,151	1,464,019	110,960,523	1,371,028	130,251,696	1,788,354

Imported from—	1903		1904		1905	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	1,051,519	$12,528	855,453	$6,775	3,874,588	$30,623
France	5,942,375	71,391	614,018	4,843	1,322,348	11,301
Germany	21,161,570	243,074	22,411,069	168,483	20,990,091	144,822
United Kingdom	79,641,953	799,533	74,448,139	585,445	68,581,632	579,385
All others	29,700	140	[3] 756,707	6,986	[1] 1,351,052	10,150
Total	107,827,117	1,126,666	99,085,386	772,532	96,119,711	776,281

Imported from—	1906		1907		1908	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	2,368,742	$19,637	1,801,484	$15,876	1,802,453	$15,771
France	2,805,452	21,770	1,853,559	14,937	2,120,215	16,098
Germany	22,643,870	154,353	19,813,102	139,531	16,423,545	113,892
United Kingdom	80,630,717	682,554	82,766,399	710,020	69,772,014	607,749
All others	107,535	946	.....	.....	117,488	991
Total	108,556,316	879,260	106,234,544	880,364	90,235,515	754,501

[1] Free from July 1 to July 24, 1897, under the act of 1894.
[2] Dutiable from July 25, 1897, to June 30, 1898 under the act of 1897.
[3] Chiefly Italy.

Bleaching powder or chloride of lime—Imports by countries (fiscal years)—Continued.

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	769,968	$6,723	700,138	$6,706	748,268	$7,862
France	1,656,677	12,881	2,034,259	15,653	4,295,308	32,867
Germany	23,525,844	161,386	24,279,836	150,121	21,092,984	143,883
United Kingdom	57,371,139	502,575	66,689,586	575,897	71,996,482	606,896
Netherlands	76,082	521	300,867	1,981	1,389,017	9,322
All other					40,516	305
Total	83,399,660	684,086	94,004,686	750,358	99,562,575	801,135

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	321,847	$3,214	245,628	$2,548	290,785	$3,009
France	3,356,377	23,579	2,146,859	15,873	2,016,324	16,003
Germany	19,487,400	133,980	18,119,803	122,159	10,751,096	76,209
United Kingdom	49,788,020	423,205	54,723,908	473,260	34,287,763	320,890
Netherlands	181,935	1,239				
Canada	135,837	1,222	38,120	324		
All others	2,610	49	1,900	21	77,681	629
Total	73,274,026	586,488	75,276,218	614,185	47,423,651	416,740

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Belgium	111,887	$1,193				
France	268,832	2,143				
Germany	2,572,509	19,108				
United Kingdom	15,174,575	174,134	2,700,975	$49,043	64,711	$3,769
Canada	22,722	425	488,701	31,389	753	113
All other			112	2	100	6
Total	18,150,525	197,003	3,189,788	80,434	65,564	3,888

Imported from—	1918		1918 [1]		1919 [1]		1920 [2]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
England			113,904	$1,756	176,978	$5,953		
Japan			600	30				
Canada	4,285	$184	425,377	9,621	240,434	2,983		
Total	4,285	184	539,881	11,407	417,412	8,936	890,642	$16,665

[1] Calendar years.

[2] First 10 months, calendar year 1920.

Bleaching powder or chloride of lime—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad-valorem rate.
Fiscal year:		*Pounds.*				*Per cent.*
1909	¼ cent per pound	83,376,089	$684,427	$166,752	$0.008	24.36
1910	do	93,838,195	750,140	187,676	.008	25.02
1911	do	99,478,325	802,015	198,957	.008	24.81
1912	do	72,706,732	600,621	145,413	.008	24.21
1913	do	76,092,327	619,492	152,184	.008	24.57
1914 [1]	do	10,720,964	90,008	21,442	.008	23.82
1914 [2]	1/10 cent per pound	37,776,275	326,895	37,796	.009	11.56
1915	do	18,402,130	197,975	18,402	.010	9.30
1916	do	3,289,790	80,418	3,290	.024	4.09
1917	do	65,564	3,888	66	.059	1.69
1918	do	535	83	0.54	.155	.65
1919	do	539,596	11,363	540	.021	4.75
Calendar year:						
1918	do	540,131	11,446	540	.021	4.72
1919	do	341,812	6,787	341	.019	5.04
1920 [3]	do	488,395	6,834	488	.014	7.14

[1] July 1 to Oct. 3, 1913. [2] Oct. 4 to June 30, 1914. [3] First 6 months of calendar year 1920.

Chloride of lime or bleaching powder—Domestic exports.

FISCAL YEARS.

Exported to—	1918 [1]		1919		1920	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Norway	730,954	$47,660				
Spain	1,022,248	36,375				
England	330,307	7,691				
Canada	2,113,182	59,417				
Argentina	3,018,980	142,091				
Brazil	2,081,210	86,834				
Chile	1,183,437	61,729				
British India	724,967	39,855				
All other	1,855,116	76,414				
Total	13,060,401	558,066	15,639,918	$450,145		

CALENDAR YEARS.

Exported to—	1918		1919		1920 [2]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Spain	1,379,992	$49,138	119,200	$3,529		
Canada	3,601,062	93,890	14,171,162	271,108		
Norway	570,704	22,035	516,787	20,877		
Mexico	181,449	7,538	395,434	13,834		
Argentina	568,936	16,451	2,465,233	79,264		
Brazil	1,291,388	46,710	911,276	36,709		
British India	247,655	13,653	429,251	11,042		
All other	1,609,587	60,868	2,011,393	436,363		
Total	9,450,793	310,268	21,019,736	517,317	38,941,680	$1,175,221

[1] Exports of bleaching powder are not shown separately in Commerce and Navigation prior to the fiscal year 1918. They were probably too small to be shown.
[2] First 10 months of calendar year 1920.

Bleaching powder or chloride of lime—Prices, wholesale (cents per pound), New York spot.

[Oil Paint and Drug Reporter.]

	1912	1913	1914	1915	1916
January	1.25–1.30	1.35–1.45	1.20–1.30	1.37–1.62	14.0
April	1.25–1.30	1.30–1.40	1.20–1.30	1.40–1.50	8.0–8.5
July	1.50–2.00	1.25–1.30	1.20–1.30	1.40–1.50	5.5–8.0
October	1.35–1.40	1.25–1.30	2.25–3.00	2.50–2.75	4.25–6.00

	1917	1918	1919	1920
January	4.37–6.50	1.25–3.50	2.25–3.50	2.60–2.75
April	3.75–6.00	2.25–3.25	1.50–2.75	4.00–5.00
July	1.75–4.00	2.0 –3.25	2.00–2.25	(1)
October	2.00–2.50	5.5 –6.0	.....	7.50–8.00

[1] Nominal.

Additional price quotations may be found in the following publications: Daily, New York Commercial; weekly, Drug and Chemical Markets; bimonthly, Chemical and Metallurgical; monthly, Journal of Industrial and Engineering Chemistry, and Chemical Engineer.

Bleaching powder (chloride of lime)—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	618	Lime, chloride of, or bleaching powder	Free.
1890	635	Lime, chloride of, or bleaching powder	Free.
1894	537	Lime, chloride of, or bleaching powder	Free.
1897	8	Bleaching powder, or chloride of lime	¼ cent per pound.
1909	8	Bleaching powder, or chloride of lime	¼ cent per pound.
1913	12	Bleaching powder, or chloride of lime	1/10 cent per pound.

Court and Treasury Decisions.

There are no decisions directly affecting the classification of bleaching powder or chloride of lime. The only questions in issue were whether certain combinations of chemicals constituted the commodity specifically provided for in the tariff acts, and whether tin containers were dutiable.

The decisions are:

Tin cans containing bleaching powder or chloride of lime.—Held not dutiable as unusual containers under the act of 1883.—Dept. Order, T. D. 6568.

The following articles were held not properly classable as bleaching powder or chloride of lime:

Chloride of calcium.—Held dutiable as a chemical compound or salt under paragraph 92 of the act of 1883.—Dept. Order, T. D. 9008.

A mixture of soap, carbonate of soda, and saponified resin.—Held dutiable as an unenumerated manufactured article under section 4 of the act of 1890.—In re Ross, G. A. 954 (T. D. 12041).

Sodium perborate, 31.57 per cent, and sodium carbonate, 68.43 per cent.—Held dutiable as a chemical compound under paragraph 3 of the act of 1909. The term "bleaching powder" was said to have a well-known significance in chemistry and to mean either calcium chloride or a mixture of calcium chloride and calcium hypochlorite, and to be synonymous with chloride of lime.—In re Oberle & Henry, Abstract 35745 (T. D. 34496).

The following articles were held not to be lime powder:

A mixture of lime, carbonate of lime, and manganese oxide, lime chief value.—Held dutiable as lime under paragraph 90 of the act of 1897.—In re Strohmeyer & Arpe Co., Abstract 21596 (T. D. 29922).

Similar merchandise.—Held dutiable as a chemical mixture under paragraph 3 of the act of 1909.—Strohmeyer *v.* U. S., 2 Ct. Cust. Appls., 285, affirming Abstract 23840 (T. D. 30865).

LIQUID CHLORINE.

[Par. 5, act of 1913. 15 per cent ad valorem.]

SUMMARY.

Description.—Chlorine is one of the chemical elements which at ordinary atmospheric conditions is a gas. It has a greenish yellow color. When subjected to pressure and refrigeration the gas liquefies, forming the liquid chlorine of commerce, which is shipped in steel cylinders. Chlorine is used in the preparation of many chemical compounds, the more important ones are bleaching powder, carbon tetrachloride, monochlorbenzol, chloroform, monochloracetic acid, tin chlorides, sulphur chlorides, and phosgene. Liquid chlorine is rapidly taking the place of bleaching powder in the purification of public water supplies.

Domestic production.—The 1914 census shows about 6,000 short tons, valued at $472,836, as being produced in the United States. Calculating from the quantity of electrolytic caustic soda produced in 1917, there was produced simultaneously 112,400 short tons of chlorine gas. Only part of this quantity was marketed, the remainder being used in the plants where produced.

Chlorine is produced in this country exclusively by the electrolytic process. In Europe it is also produced by the Weldon and Deacon processes.

Chlorine is produced as a joint product with caustic soda. Since electricity is used in the manufacture it follows that large quantities should be made at Niagara Falls. This industry, however, is not as dependent on cheap water power as the other electrochemical industries, and there are several plants located in different parts of the country which produce chlorine.

There is no direct competition from foreign sources in liquid chlorine, only chlorine products such as bleaching powder being imported.

The installation of an electrolytic chlorine plant involves a considerable initial outlay of capital for buildings, power equipment, and electrolytic cells.

Price.—Liquid chlorine sells at about 15 cents per pound. It has only been quoted on the open market since about July, 1916.

Tariff history.—Chlorine or liquid chlorine has not been mentioned by name in any of the tariff acts.

GENERAL INFORMATION.

Description.—Chlorine is one of the elements which at ordinary temperatures and pressures is a greenish-yellow gas. It is never found free in nature, but occurs in the combined form chiefly as the chloride of sodium, potassium, calcium, and magnesium. Of these compounds, the chloride of sodium (salt) is the source of all the chlorine produced in the United States.

Chlorine, even when greatly diluted with air, has a characteristic irritating odor. It can not be breathed to any extent, as it readily attacks the membranes and is very suffocating. When inhaled in small quantities it produces colds and larger quantities cause vomiting and the spitting of blood. The gas is incombustible in air, but burns in an atmosphere of hydrogen with the formation of hydrochloric acid. Chlorine can be liquefied by cooling the gas to minus 34° C. or by subjecting it to a pressure of about 6 atmospheres. It is this property and the fact that dry chlorine does not attack iron or steel that has made practicable the shipment of chlorine as a liquid in iron and steel cylinders.

Chlorine is a very active chemical agent and combines with many substances at ordinary temperatures. The presence of water causes chlorine to act on many substances that in the dry state would be unaffected. Dry chlorine by itself or in the presence of sulphuric acid has no action on cast iron, wrought iron, steel, phosphor bronze, brass, copper, zinc, or lead.

Raw materials.—Chlorine is produced in this country exclusively by the electrolysis of solutions of sodium chloride (salt). The salt for this purpose should be pure, or must be purified before being electrolyzed. The salt particularly should contain no sulphates or barium salts. With very few exceptions, the salt produced in this country is admirably suited for the manufacture of chlorine by the electrolytic method.

Process of manufacture.—The production of chlorine in the United States consists in passing a direct electric current through a solution of salt in a suitable apparatus, which is known as an electrolytic cell. Since the details of the manufacture vary with the type of electrolytic cell used, only the essential steps in the process will be described.

Common salt is dissolved in water to form a saturated solution which is purified by treatment with soda ash, thus removing any calcium, magnesium, iron, or barium salts that may be present. The solution is then allowed to settle or is filtered to remove the precipitated impurities. The clear solution of salt is then fed to the electrolytic cells either as a neutral acid or alkaline solution according to individual practice. The salt solution as it passes through the cell is subjected to the action of the electric current which decomposes the salt into chlorine and sodium. The chlorine gas is withdrawn from the cells by means of a vacuum on the chlorine compartment of the cell.

For the production of liquid chlorine the gas is now thoroughly dried, usually by the means of concentrated sulphuric acid. It is then compressed by means of a special type of compressor and then subjected to refrigeration which causes it to liquefy. The resulting liquid chlorine is stored and shipped in steel cylinders which hold about 150 pounds of chlorine. These cylinders are tested to withstand about 600 pounds pressure. The chlorine by liquefaction is reduced in volume in about the ratio of 400 to 1.

It is advantageous to have a source of cheap electrical power, such as water power for the manufacture of chlorine. This factor, however, does not appear to be of as vital importance in this industry as in the other electrochemical industries. There are several electro-

lytic chlorine plants which produce their electric current for electrolysis by steam installations.

The manufacture of electrolytic chlorine requires a relatively small amount of labor, as the process is continuous and to a large extent automatic.

The principal types of electrolytic chlorine cells used in the United States are the Townsend, Castner-Kellner, Dow, Gibbs, Nelson, Allen-Moore, Wheeler, and the Billiter-Siemens.

In addition to the electrolytic method, chlorine is produced in Europe by two other processes, the Weldon and Deacon. The former consists in producing chlorine by the oxidation of hydrochloric acid by the means of manganese dioxide (pyrolusite). The latter process produces chlorine by passing a mixture of hydrochloric acid gas and air over copper salts at a temperature of about 460° C. Both of these processes are more complicated than the electrolytic one.

Important uses.—Chlorine is used in the manufacture of the following products: Bleaching powder, carbon tetrachloride, chloroform, sulphur chlorides, chloral hydrate, monochloracetic acid, phosphorus chlorides, phosgene, tin chlorides, iron chloride, aluminum chloride, acetylene tetrachloride, ethylene chloride, methane chlorides, bromine.

Chlorine is used in the chlorination of many organic compounds, such as benzol, toloul, napthalene, and anthracene.

It is used directly or in the form of bleaching powder for the bleaching of cotton and linen goods.

Liquid chlorine is practically supplanting bleaching powder for the purification of water supplies, especially in the larger cities.

Chlorine is used to some extent in the recovery of gold and silver. This use at one time was very promising but has not met with the success that was expected and therefore this use of chlorine is decreasing.

It is used as an oxidizing agent in the manufacture of arsenic acid in the preparation of lead arsenate.

History of the industry.—Chlorine has been known since 1774 when it was first prepared by Scheele. The industrial application of chlorine was developed during the years following 1868. During this time the Weldon and Deacon processes were put into successful operation on an industrial scale. Both of these processes have never been introduced into this country. In 1897 the electrolytic chlorine industry was established in the United States for the manufacture of bleaching powder.

The development of the liquefaction of chlorine began in Europe in about 1890 and since that time has gained considerable importance. The liquefying of chlorine and the development of the uses for liquid chlorine in this country have been within recent years. Since the introduction of liquid chlorine in the United States the industry has progressed rapidly, owing to the increased demands for liquid chlorine as a bleaching agent and for the purification of public water supplies.

The chief disadvantage of liquid chlorine is the initial cost of the cylinders and the fact that the cylinders must be returned to the manufacturer for refilling. This latter fact makes it doubtful whether liquid chlorine will completely replace bleaching powder as a means of exporting chlorine.

Chlorine and liquid chlorine—Production in United States.

OFFICIAL SOURCE.

Year.	Quantity.	Value.
	Pounds.	
1899	.....	$31,469
1904	.....	98,853
1909	.....	332,187
1914	12,217.000	472,836

OTHER SOURCES.

[From United States Geological Survey.]

	Short tons.
1917 [1]	112,400

NOTE.—Listed as chlorine.

[1] The Geological Survey reported the production of 126,570 short tons of caustic soda as being produced electrolytically. Simultaneously there would have been produced about 112,400 short tons of chlorine. This amount was not all marketed, as some was consumed in the plants where produced.

Liquid chlorine—Prices, wholesale (cents per pound), spot New York.

[Oil Paint and Drug Reporter.]

Year.	January.	April.	July.	October.
1916	.....	.....	15–24	15–24
1917	.....	11½–12.3	14–15	14–15
1918	14–16	(1)	15½–17	7½–20
1919	11–13	10–15	8–10	.....
1920	7– 8	8– 9	9–10	9½–11

[1] Nominal.

CAFFEINE AND CAFFEINE COMPOUNDS.

[Par. 13, act of 1913.]

SUMMARY.

The manufacture of the alkaloid, caffeine, in the United States is a relatively small industry and is restricted to a few firms. Prior to the war it supplied approximately two-thirds of the domestic consumption, and has an output of about 150,000 pounds, worth in the neighborhood of $500,000. Its principal competitor, the German chemical industry, was cut off from the American market in 1915, and imports immediately fell from 54,000 pounds in 1915 to an average of less than 3,000 pounds for the period 1916–1920. The domestic production had increased in 1919 to 241,615 pounds, valued at $1,673,682. The price of the alkaloid, which was about $3.25 per pound in 1914, has practically doubled since that time. During the scarcity in 1916 it reached a maximum of $17 per pound.

Although a number of familiar plant products contain caffeine, the raw material best suited for its commercial manufacture has proved to be the dust, sweepings, and waste obtained from the tea industry. A very small quantity of caffeine is obtained from the dust and crustations recovered from the flues of coffee-roasting plants, while in Germany the product was prepared prior to the war by extraction of the whole coffee beans. The coffee so extracted was sold as "decaffeinated" coffee. The process was also put into operation in this country, and some caffeine is reported to have been produced in this way. Caffeine has also been prepared synthetically from uric acid. Caffeine and its compounds are used in medicine, but the predominant use is in the manufacture of soft drinks of the Coca Cola type.

The Japanese chemical industry is now attempting to secure Germany's former position as a dominating factor in the caffeine trade. Japan possesses several competitive advantages, the most important of which, perhaps, is her close proximity to an abundant source of the raw material. Tea waste, which contains only about 2 per cent of caffeine, is a very bulky material, and the American manufacturers have found its transportation expensive as well as difficult to secure.

The tariff problem of chief interest is the relation between the rates of duty on the raw material and the finished product. Since 1913 the former has been dutiable at 1 cent per pound and the rate on caffeine has been $1 per pound. Since about 50 pounds of tea waste are required to produce 1 pound of caffeine, the duty on the raw material amounts to 50 cents per pound of caffeine contained. This duty, together with the large difference in ocean-freight rates, favors the importation of the prepared alkaloid rather than its raw material.

GENERAL INFORMATION.

PROVISIONS IN THE ACT OF 1913.

13. Caffein, $1 per pound; compounds of caffein, 25 per cent ad valorem; impure tea, tea waste, tea siftings or sweepings, for manufacturing purposes in bond, pursuant to the provisions of the act of May 16, 1908, 1 cent per pound.

NOTE.—The act of May 16, 1908, is given in T. D. 29311. See page 33.

DESCRIPTION AND USES.

Occurrence.—Caffeine is an alkaloid obtained principally from tea leaves, and also occurring in coffee beans, kola nuts, guarana, mate or Paraguay tea, and in several other plant products. Caffeine is present in these materials in approximately the following proportions: Tea, 1 to 4.8 per cent; coffee, 1 to 1.5 per cent; kola nuts, 2.7 to 3.6 per cent; mate, 1.25 to 2 per cent; gurana, 3.1 to 5 per cent.

Tea leaves generally contain more caffeine than do the other materials, and since at times they are collected in condition unfit for use as a beverage, they offer the best raw material for caffeine manufacture.

Description.—Caffeine appears on the market in a grade which corresponds to the specifications of the United States Pharmacopœia. It is described as "white, flexible, silky glistening needles, usually matted together in fleecy masses, odorless, and having a bitter taste." Caffeine is also known as theine and guaranine.

Uses.—Caffeine is used in medicine and also in the preparation of many soft drinks. It is recognized as a valuable stimulant diuretic, although it is being replaced to a considerable extent in this connection by related alkaloids, theobromine, and theophylline. Its well-known effects as a cerebral stimulant are largely responsible for its extended use in such familiar beverages as tea and coffee.

Caffeine is a common ingredient of headache remedies of the proprietary type, such as "bromo seltzer," "bromo caffeine," etc.

Caffeine is the main active principle of numerous soft drinks of the "Coca-Cola" type. While its ostensible source in these products is the kola nut, considerable quantities of the prepared alkaloid are known to be used in their manufacture. The amount of caffeine in these drinks varies widely, but per glass it is usually approximately equivalent to that in a cup of coffee or tea. The physiological effect of repeated use of these drinks has been a much disputed matter and has been the subject of considerable litigation under the food and drug act.

It is estimated that approximately 60 per cent of the total consumption of caffeine is used in the manufacture of soft drinks and 40 per cent in medicines. The bulk of the latter portion is probably consumed in proprietary preparations.

Caffeine compounds.—The official compounds of caffeine are the citrate, effervescent citrate, sodio-benzoate, and sodio-salicylate. There are a number of other compounds of limited use, the most important of which are the hydrobromide, hydrochloride, and sulphate. Caffeine citrate contains about 48 per cent of caffeine and is very unstable; the effervescent citrate contains only about 2 per cent of caffeine. In general the uses of the caffeine compounds are those of the alkaloid.

Tea sweepings.—Tea siftings, sweepings, tea dust, etc., are the inferior qualities of tea leaves which are unfit for consumption as a beverage. For the most part they are waste products swept up from the floors of warehouses, shipping docks, and vessels in which tea has been packed or shipped. Inferior grades of tea are occasionally mixed with lime and other ingredients which, while rendering this product unfit for beverage use, do not interfere with the manufacture of caffeine. The caffeine content of tea waste used in the United States for the manufacture of caffeine averages about 2 per cent.

Domestic production.—Caffeine is produced in the United States by a comparatively small number of manufacturers. According to figures compiled from the reports made to the United States Tariff Commission by the manufacturers, the domestic production in 1918 amounted to 204,419 pounds, valued at $1,811,489. In 1919 the output increased to 241,615 pounds, but the total value dropped to $1,673,682.

The domestic manufacturers reporting to the Tariff Commission during 1918 and 1919 were the Abbott Laboratories of Chicago, Ill.; Citro Chemical Co. of America and Maywood Chemical Works, Maywood, N. J.; Monsanto Chemical Works, St. Louis, Mo.; and Frederick Stearns & Co., Detroit, Mich.

Small quantities [1] of caffeine have been recovered from the crustations formed in the flues of coffee-roasting plants; another process which has been carried on to some extent in this country consists in extracting the caffeine from the whole coffee beans, which are then sold as "decaffeinated coffee." The process was controlled by a German firm, who sold the product under the trade name "Kaffee-Hag."

Prior to the war the domestic industry supplied about two-thirds of the domestic consumption and the bulk of the remainder came from Germany. During the war the elimination of the German product from the domestic market resulted in increased production to such an extent that since 1916 the domestic industry has practically supplied the entire consumption.

History and foreign production.—Caffeine was discovered in coffee in 1820 and in tea in 1827. It was first prepared synthetically in 1895 by the German chemist Emil Fischer. The alkaloid has been manufactured in the principal European countries, the industry being especially well developed in Germany. There it is reported to have been prepared synthetically from uric acid obtained from guano. Theobromine and theophylline, two closely related alkaloids, are also prepared from uric acid.

Prior to the war Japan exported large quantities of tea waste to Germany and other countries, where it was manufactured into caffeine, some of which was returned to Japan in prepared form. This trade was largely affected by the war, with the result that several Japanese firms took up the manufacture of caffeine. According to a recent report [2] these firms have now consolidated and hope to take advantage of the position of Japan in the tea trade. The new company, organized November 29, 1919, is capitalized at $500,000 and has a productive capacity of approximately 50,000 pounds. Manufacture

[1] Estimated to be less than 1 per cent of the annual production.
[2] Caffeine Trade Control Planned, Oil, Paint, and Drug Reporter, Jan. 12, 1920, confirmed by reports from Far Eastern Division of the Department of Commerce.

in the United States began in 1895, at a time when the annual consumption was about 25,000 pounds.

The Department of Agriculture has recently called attention to two possible new sources of caffeine.[3] One source is the native plant, *Ilex vomitoria*, which is a species of holly growing abundantly throughout the South Atlantic States. The plant has long been used for the preparation of a native beverage known as "Yaupon Tea," but its content of caffeine (about 1 per cent) has never been recovered commercially. The cost of collecting the leaves under present conditions is probably too high to permit Ilex to compete with tea waste as a source of caffeine. The second source, which appears to be more promising, is the pulp of the coffee berry. This material, which represents approximately one-third of the weight of the coffee berries as picked, is removed and either discarded as a waste product or used only for manuring purposes. Department officials in Porto Rico point out that 50 to 80 million pounds of fresh pulp are available annually in that country alone. Analyses of the dried pulp show a content of 0.8 to 0.9 per cent of caffeine.

Methods of manufacture.—Caffeine occurs partly in a free state and partly combined, usually with tannic acid. It is commercially prepared almost exclusively from tea sweepings. It may be extracted directly by such solvents as benzol, and chloroform, in which case the caffeine is purified by repeated water crystallizations. According to another method the tea waste is boiled with water and the aqueous infusion is freed from tannins, coloring matter, etc., by precipitation with lead acetate. After the removal of the lead by means of hydrogen sulphide, the caffeine is crystallized from the concentrated filtrate.

IMPORTS.

The average annual import of caffeine for the period 1909 to 1914 was 49,278 pounds, valued at $143,105. Germany supplied about 98 per cent of the imports in 1914 and accordingly, when the war cut off this source of supply, there was a marked decrease. From 54,323 pounds in 1915, imports dropped to 1,267 pounds in 1916. The annual imports for the period 1916–1920 were less than 3,000 pounds. The value per unit of quantity has varied considerably, increasing from a minimum of $1.66 in 1910 to $12.02 in 1916. The reported value during 1918 and 1919 was slightly less than $10 per pound, and in 1920 dropped to about one-half this figure.

Imports of caffeine compounds were reported only in 1914, 1915, and 1916. They have been small and of practically no significance.

Tea waste and other impure grades useful only for manufacturing purposes have been imported in considerable amounts. Prior to the war the imports averaged about 4,000,000 pounds. The imposition of the duty in 1914 did not affect the quantity, which for the period 1914–1919 averaged 6,354,069 pounds, valued at $360,991. In 1914 about 65 per cent of the imports were received from British India and 24 per cent from Japan.

PRICES.

Caffeine prior to the war sold for $3 to $3.50 per pound and prices showed little variation until the middle of 1915, when they rose first

[3] Power, F. B., and Chesnut, V. K., Journal of the American Chemical Society, XLI, pp. 1298–1312, 1919.

to $6 and later to $10 to $12 per pound. The maximum price for the alkaloid was $17, quoted in July, 1916. Wholesale prices for caffeine and its compounds are shown on pages 32 and 33.

TARIFF HISTORY.

Caffeine was first mentioned specifically in the tariff act of 1913, which provided a duty of $1 per pound for the alkaloid and an ad valorem duty of 25 per cent for caffeine compounds. Caffeine had previously been classified as a medicinal preparation under one of the general provisions and since 1897 had been dutiable at 25 per cent ad valorem. The specific rate imposed by the act of 1913 was equivalent to practically 30 per cent ad valorem during 1914–15. For 1916–1919, however, the highest ad valorem rate was 10.09 per cent.

Impure tea sweepings and dust were variously classified before specific provision therefor in 1913. When mixed with slacked lime or asafetida they were held to be exempt from duty as a crude drug or crude vegetable substance. (T. D. 22730; G. A. 4856, T. D. 22766.) The act of 1913 imposed a duty of 1 cent per pound, which in 1915 was equivalent to 30.90 per cent ad valorem. Later increases in price have lowered this equivalent until in 1919 it amounted to 13.07 per cent.

TARIFF CONSIDERATIONS AND COMPETITIVE CONDITIONS.

Caffeine manufacture was begun in the United States in 1895 and before the war the industry supplied approximately two-thirds of the domestic consumption. The principal competitor was the German chemical industry, which manufactured caffeine from tea waste imported from British India and from uric acid as a joint product in the synthesis of the related alkaloids, theophylline and theobromine. When the war cut off Germany's export trade, a number of Japanese tea companies took up the manufacture of caffeine and within the last few years have made considerable progress. The raw material, tea waste, was present in abundance, but before the war Japan did not produce benzol or the other solvents necessary to extract the caffeine from the tea. This difficulty was overcome with the development of munitions manufacture. The Japanese manufacturer has his raw material at hand and his wage scale is also considerably lower than in the United States.

The American manufacturer importing tea waste pays ocean and rail freight on a cheap and very bulky material. Reports received by the tariff commission from the manufacturers indicate that the ocean freight from China and Japan varied between $1 and $2 per hundred pounds during 1919. The rates from British India ranged between $1.50 and $2.50 per hundred pounds. In addition, there are handling charges and rail freight to the manufacturers' plants, so that 2 cents per pound appear to be a fair average for the total freight charges. The charges on the quantity of tea waste equivalent to a pound of caffeine is therefore $1. To this is added the duty on 50 pounds of tea waste, which under the act of 1913 amounts to $50. It is therefore apparent that the duty, together with the difference in freight rates, favors the importation of the prepared alkaloid rather than its raw material.

Exports of tea dust from Japan.[1]

Year.	Total exports.		Exports to United States.
	Pounds.	*Dollars.*	*Pounds.*
1913	3,662,282	132,851	2,832,151
1914	4,118,681	147,786	3,114,593
1915	3,545,703	144,328	2,502,768
1916	4,482,729	234,133	3,012,992
1917	4,636,740	245,985	3,382,855
1918	4,230,216	308,514	3,528,427
1919	2,415,203	350,976	.....

[1] From Official Japanese Trade Returns.

British imports of tea for the manufacture of Caffeine.[1]

Year.			Year.		
	Pounds.	*Dollars.*		*Pounds.*	*Dollars.*
1907	1,285,311	47,142	1914	990,498	35,506
1908	1,103,248	40,046	1915	915,425	32,231
1909	992,339	32,357	1916	995,219	46,161
1910	1,354,318	42,655	1917	764,857	63,372
1911	1,104,470	32,026	1918	485,394	56,870

[1] Over 95 per cent of the imports are furnished by British India and Ceylon. From Annual Statement of Trade of the United Kingdom with Foreign Countries and British Possessions.

Imports of caffeine for consumption in the United States.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1909	25 per cent	17,291	43,381	10,845	2.51	25.00
1910	.....do	60,463	100,491	25,122	1.66	25.00
1911	.....do	33,929	104,011	26,002	3.07	25.00
1912	.....do	43,859	139,067	34,766	3.17	25.00
1913	.....do	59,773	211,361	52,840	3.54	25.00
[1] 1914	.....do	25,100	81,851	20,462	3.26	25.00
[2] 1914	$1 per pound	55,250	178,472	55,250	3.23	30.96
1915	.....do	54,323	186,557	54,323	3.43	29.12
1916	.....do	1,267	15,228	1,267	12.02	8.32
1917	.....do	1,601	17,219	1,601	10.76	9.30
1918	.....do	6,471	64,529	6,471	9.96	10.03
1919	.....do	2,662	26,383	2,662	9.91	10.09
1920	.....do	2,992	14,884	2,992	4.98	20.01

[1] July 1 to Oct. 3, 1913, act of 1909. [2] Oct. 4, 1913, to June 30, 1914, act of 1913.

Imports of caffeine compounds for consumption in the United States.

Fiscal years.	Rates of duty.	Values.	Duties collected.	Actual and computed ad valorem rate.
		Dollars.	*Dollars.*	*Per cent.*
1914	25 per cent	9,712	2,428	25
1915	.....do	4,071	1,017	25
1916	.....do	605	151	25

Imports of tea, impure, waste, siftings, or sweepings for manufacturing purposes for consumption—Revenue.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1909	Free	2,325,146	76,172	.....	0.033	.....
1910	.....do	3,442,074	100,450	.....	.029	.....
1911	.....do	3,735,889	94,302	.....	.025	.....
1912	.....do	5,994,507	161,540	.....	.027	.....
1913	.....do	7,168,410	215,938	.....	.030	.....
1914[1]	.....do	1,463,677	47,195	.....	.032	.....
1914[2]	1 cent per pound	3,750,279	131,107	37,502	.035	28.60
1915	.....do	4,739,208	153,360	47,392	.032	30.90
1916	.....do	4,796,766	201,507	47,967	.042	23.80
1917	.....do	7,626,688	478,326	76,266	.063	15.94
1918	.....do	10,887,595	782,473	108,875	.072	13.91
1919	.....do	4,860,200	371,975	48,602	.077	13.07
1920	.....do	11,076,802	717,592	110,077	.065	15.3[illegible]

[1] Act of 1909, July 1 to Oct. 3, 1913. [2] Act of 1913 Oct. 4, 1913, to June 30, 1914.

Caffeine, alkaloid, prices per pound, wholesale, New York, spot.

[From Oil Paint and Drug Reporter.]

	Cents.		Cents.
Jan. 1, 1912[1]	3.15– 3.25	Oct. 2, 1916	13.00–15.00
Apr. 1, 1912[1]	3.15– 3.25	Jan. 1, 1917	11.25–11.50
July 1, 1912[1]	3.15– 3.25	Apr. 2, 1917	11.50
Sept. 30, 1912[1]	3.15– 3.25	July 2, 1917[2]	2.50–13.00
Dec. 30, 1912[1]	3.15– 3.25	Oct. 1, 1917	11.00–11.50
Mar. 31, 1913[1]	3.15– 3.25	Dec. 31, 1917	12.50–13.00
June 30, 1913[1]	3.15– 3.25	Jan. 5, 1918	12.50–13.00
Sept. 29, 1913[1]	3.50	Apr. 1, 1918	13.25–13.50
Dec. 29, 1913[1]	3.65– 3.75	July 1, 1918	11.50–12.00
Mar. 30, 1914[1]	3.65– 3.75	Oct. 7, 1918	11.50–12.00
June 29, 1914[1]	3.65– 3.75	Jan. 6, 1919	10.00–11.75
Sept. 28, 1914[1]	5.00– 6.00	Apr. 7, 1919	6.75– 7.00
Dec. 28, 1914[1]	4.25– 4.60	July 7, 1919	6.75– 7.00
Mar. 29, 1915	3.65– 4.00	Oct. 6, 1919	7.25– 7.50
June 28, 1915	4.75– 6.00	Jan. 5, 1920	7.00– 7.25
Sept. 27, 1915	10.25–10.50	Apr. 5, 1920	9.25– 7.30
Jan. 3, 1916	11.50–12.00	July 5, 1920	7.85– 8.00
Apr. 3, 1916	13.00–13.50	Oct. 4, 1920	7.50– 7.75
July, 1916	17.00		

[1] Listed as "Caffeine." [2] Nominal.

Caffeine, citrated, prices per pound, wholesale, New York, spot.

[From Oil Paint and Drug Reporter.]

	Cents.		*Cents.*
June 28, 1915	3.35– 3.50	Apr. 1, 1918	8.00
Sept. 27, 1915	5.75– 6.25	July 1, 1918	8.00
Jan. 3, 1916	6.50	Oct. 6, 1918	8.00
Apr. 3, 1916	6.50	Jan. 6, 1919	8.00
July 3, 1916	10.50–10.75	Apr. 7, 1919	8.00
Oct. 2, 1916	7.50– 8.00	July 7, 1919	6.15– 6.25
Jan. 1, 1917	7.00– 7.25	Oct. 6, 1919	6.15– 6.25
Apr. 21, 1917	7.50	Jan. 5, 1920	6.15– 6.25
July 2, 1917	8.00	Apr. 5, 1920	6.10– 6.25
Oct. 1, 1917	7.00– 7.50	July 5, 1920	6.25– 6.30
Dec. 31, 1917	7.50	Oct. 4, 1920	6.00– 6.15
Jan. 5, 1918	7.50		

Caffeine, hydrobromide, prices per pound, wholesale, New York, spot.

[From Oil Paint and Drug Reporter.]

	Cents.		*Cents.*
July 3, 1916	10.70–12.00	Oct. 7, 1918	10.70–12.00
Oct. 2, 1916	10.70–12.00	Jan. 6, 1919	10.70–12.00
Jan. 1, 1917	10.70–12.00	Apr. 7, 1919	10.70–12.00
Apr. 2, 1917	10.70–12.00	July 7, 1919	8.50– 8.75
July 2, 1917	10.70–12.00	Oct. 6, 1919	8.25– 8.50
Oct. 1, 1917	10.70–12.00	Jan. 5, 1920	8.25– 8.50
Dec. 31, 1917	10.70–12.00	Apr. 5, 1920	8.25– 8.50
Jan. 5, 1918	10.70–12.00	July 5, 1920	8.00– 8.25
Apr. 1, 1918	10.70–12.00	Oct. 4, 1920	8.00– 8.25
July 1, 1918	10.70–12.00		

Caffeine, phosphate, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
July 3, 1916	17.50–17.55	Oct. 7, 1918	14.00–15.00
Oct. 2, 1916	17.50–17.55	Jan. 6, 1919	14.00–15.00
Jan. 1, 1917	17.50–17.55	Apr. 7, 1919	14.00–15.00
Apr. 1, 1917	17.50–17.55	July 7, 1919	10.40–10.50
July 2, 1917	17.50–17.55	Oct. 6, 1919	10.40–10.50
Oct. 1, 1917	17.50–17.55	Jan. 5, 1920	10.40–10.50
Dec. 31, 1917	15.00–16.00	Apr. 5, 1920	10.25–10.35
Jan. 5, 1918	15.00–16.00	July 5, 1920	10.00–10.25
Apr. 1, 1918	14.00–15.00	Oct. 4, 1920	10.00–10.25
July 1, 1918	14.00–15.00		

Caffeine, sulphate, prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

	Cents.		Cents.
July 3, 1916	18.80–18.85	Oct. 7, 1918	15.00–16.00
Oct. 2, 1916	18.80–18.85	Jan. 6, 1919	15.00–16.00
Jan. 1, 1917	18.80–18.85	Apr. 7, 1919	15.00–16.00
Apr. 2, 1917	18.80–18.85	July 7, 1919	9.40– 9.50
July 2, 1917	18.80–18.85	Oct. 6, 1919	9.40– 9.50
Oct. 1, 1917	18.80–18.85	Jan. 5, 1920	9.40– 9.50
Dec. 31, 1917	16.00–16.50	Apr. 5, 1920	9.25– 9.35
Jan. 5, 1918	16.00–16.50	July 5, 1920	9.25– 9.35
Apr. 1, 1918	15.00–16.00	Oct. 4, 1920	9.25– 9.35
July 1, 1918	15.00–16.00		

Caffein and compounds of caffein—Rates of duty.

Act of—		Tariff classification or description.	Rates of duty, specific and ad valorem.
Year.	Par.		
1883	.....	Not specially provided for	
1890	.....	.....do	
1894	.....	.....do	
1897	.....	.....do	
1909	65	.....do	25 per cent.
1913	13	Caffein	$1 per pound.
		Compounds of caffein	25 per cent.

COURT AND TREASURY DECISIONS.

Decisions under the act of 1909:

(T. D. 34218—G. A. 7536), February 26, 1914. Treasury Decisions, vol. 26, pp. 340–341.

Caffeine was held to be a medicinal preparation under paragraph 65, act of 1909, and therefore dutiable at 25 per cent ad valorem, following the principle established by Lehn & Fink *v.* United States, 4 Ct. Cust. Appls., 325; T. D. 33522.

(T. D. 29311.) Importation of low-grade tea, tea waste, etc., for manufacturing purposes under the act approved May 16, 1908.

TREASURY DEPARTMENT, *October 28, 1908.*

The appended act of Congress is published for the information and guidance of all concerned:

AN ACT To amend an act entitled "An act to prevent the importation of impure and unwholesome tea" approved March 2, 1897.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 1 of "An act to prevent the importation of impure and unwholesome tea" approved March 2, 1897, be amended by adding at the end thereof the following words: "*Provided,* That nothing herein shall affect or prevent the importation into the United States, under such regulations as the Secretary of the Treasury may prescribe, of any merchandise as tea, which may be inferior in

purity, quality, and fitness for consumption to the standards established by the Secretary of the Treasury, or of any tea waste, tea siftings, or tea sweepings, for the sole purpose of manufacturing theine, caffeine, or other chemical products whereby the identity and character of the original material is entirely destroyed or changed; and that importers and manufacturers who import or bring into the United States such tea, tea waste, tea siftings, or tea sweepings shall give suitable bond, to be approved as to the amount and securities by the Secretary of the Treasury, conditioned that said imported material shall be only used for the purposes herein provided, under such regulations as may be prescribed by the Secretary of the Treasury."

Tea sweepings mixed with lime and asafetida to make them unfit for beverage use, imported for making caffeine, have been held to remain tea sweepings for tariff purposes. (7 Ct. Cust. Appls., 128, of 1916). Duty may not be separately imposed on tea sweepings and lime unless it is shown that the commodities have each maintained their identity in the mixture and there is proof of the quantity of each. (7 Ct. Cust. Appls., 340, of 1916.) Allowance for excessive moisture in tea waste has been held proper. (Abstract 41371, of 1917.)

(T. D. 38470: Tea regulations of Department of Agriculture.) Under the act of May 31, 1920, the Secretary of Agriculture took over powers and duties of the Secretary of the Treasury prescribed in act of March 2, 1897, and amendment above cited.

MERCURIAL PREPARATIONS.

[Par. 14, act of 1913, 15% ad val.]

General Information.

Description, uses, preparation.—The mercurials or compounds of mercury used primarily for pharmaceutical and medicinal purposes are mentioned in the act of 1913 in paragraph 14 as follows:

Par. 14. "Calomel, corrosive sublimate, and other mercurial preparations, 15 per centum ad valorem."

The two compounds mentioned by name (calomel and corrosive sublimate) are the most important of the mercurials. Both of these compounds contain mercury and chlorine gas.

Corrosive sublimate, mercuric chloride, mercury bichloride, mercury perchloride, corrosive mercury chloride, or simply "bichloride" is a chemical compound ($HgCl_2$) containing about 73.8 per cent of mercury and about 26.2 per cent of chlorine. It is either a white transparent mass or lustrous crystals. Corrosive sublimate is soluble in water and is extremely poisonous. The best antidote for corrosive sublimate poisoning is egg white.

Corrosive sublimate is used in medicine both internally and externally. It has valuable antiseptic properties and is used in surgery in dilute solution and in gauzes and lint. Technically it is used for preserving wood and anatomical specimens, in embalming, and disinfecting.

It is prepared by subliming a mixture of mercuric sulphate and salt. The mercuric sulphate is first prepared by gently heating mercury with concentrated sulphuric acid until the fumes of sulphur dioxide are no longer evolved, and evaporating the mixture to dryness. The mercuric sulphate is now intimately mixed with salt and a little manganese dioxide to prevent the formation of calomel. The mixture is placed in glass retorts which are heated on a sand bath. The corrosive sublimate sublimes and deposits in the upper and colder portions of the glass retort. The retort must then be broken to remove the sublimate which has formed.

Corrosive sublimate is also prepared industrially by passing chlorine gas over mercury heated almost to the point of evaporation. The sublimate formed is condensed in the cold portions of the glass flask and removed as described above. This would seem to be a much simpler and less expensive method.

Calomel, mercurous chloride, or mercury monochloride is a chemical compound composed of about 85 per cent of mercury and 15 per cent of chlorine. It has the chemical formula Hg_2Cl_2. Calomel is an impalpable powder, usually yellowish-white and insoluble in water. It sublimes between 400 and 500 degrees without melting, this property being used in obtaining a pure product.

The largest use of calomel is for medicinal purposes, both internally and externally. Its technical uses are small and unimportant.

Calomel is usually prepared from corrosive sublimate which has been described above. A mixture of about 4 parts of corrosive sublimate and 3 parts of mercury are heated in a covered iron pan. The gray mass is heated gently until it becomes white, the temperature is then increased and the calomel produced sublimes on to a plate placed inside of the pan. This product is then washed repeatedly with water and dilute nitric acid.

It may also be prepared by treating a solution of mercurous nitrate with salt (sodium chloride), or by passing sulphur dioxide into a solution of corrosive sublimate.

Other mercurials which are important commercial articles are mercuric sulphate, blue mass U. S. P., red precipitate, and white precipitate. Price quotations for these articles on the open market will be found on page 38.

Mercuric sulphate, normal or neutral mercuric sulphate, mercury persulphate or mercury bisulphate, is a chemical compound produced when mercury is heated with sulphuric acid. Its preparation has been described under corrosive sublimate. From a chemical standpoint the name mercury bisulphate indicates an acid sulphate, and is therefore erroneous; this name is used in listing price quotations of this article (p. 38). It is a white crystalline powder having the chemical formula $HgSO_4$. Mercuric sulphate is used principally in the preparation of calomel and corrosive sublimate, as described above. It is also used with potassium bisulphate for filling galvanic batteries.

Blue mass, U. S. P., is a mixture containing mercury, and has the following composition:

	Grams.
Mercury	33
Oleate of mercury	1
Glycyrrhiza, in No. 60 powder	10
Althaea, in No. 60 powder	15
Glycerin	9
Honey of rose	32

The U. S. Pharmacopœia specifies that it shall contain not less than 32 per cent nor more than 34 per cent of Hg_6 (mercury). It is used for medicinal purposes.

Red precipitate, red oxide of mercury, or mercuric oxide, is a compound composed of mercury and oxygen. It is a heavy, bright, orange-red powder, slightly soluble in water, and very poisonous. Red mercuric oxide is usually prepared by heating mercuric nitrate until nitrous fumes are no longer evolved. This gives a fine red crystalline product. A mercuric oxide having the same chemical composition, but yellow in color, is obtained by adding an alkali to a cold solution of a mercuric salt. However, if this precipitate is boiled after being precipitated, it becomes red in color. Sometimes the yellow product is preferred, as it is usually a finer powder and is more active chemically. Red precipitate is used for medicinal purposes and technically for preparing other mercurials, as a paint for ships' bottoms and for diluting pigments for painting on porcelain. It is frequently used for chemical purposes as an oxidizing agent.

White precipitate, ammoniated mercury chloride, mercury, and ammonium chloride or aminomercuric chloride contains not less than

75 per cent nor more than 80 per cent of mercury. It is marketed in the form of white, pulverulent pieces of as a white amorphous powder. It is insoluble in water, but is gradually converted into a yellow basic salt by water. This white precipitate is prepared by treating a solution of mercuric chloride (corrosive sublimate) with an excess of ammonia. It is used externally as an ointment for sores and skin diseases, but it is not used internally. This white precipitate should not be confused with the French "white precipitate" (precipité blanc), which is calomel.

Organization.—The production of mercurials for medicinal purposes is not a separate industry, but us carried out in conjunction with the manufacture of other pharmaceutical and medicinal products.

Production and consumption.—The production of mercurial salts in this country in 1914 was 605,701 pounds, valued at $518,023. This quantity supplies a large part of the domestic consumption, as the imports are small.

Imports.—The imports of mercurials averaged in value about $35,000 until 1915, when they began to decrease, until in 1918 they were valued at only $3,124. The duty on mercurials was lowered in 1913 from 35 per cent to 15 per cent ad valorem.

Tariff history.—Mercurial medicinal preparations were dutiable at 35 per cent ad valorem under the acts of 1890, 1897, and 1909. The act of 1894 did not specifically provide for mercurial medicinals. This duty of 35 per cent was reduced by the act of 1913 to 15 per cent ad valorem. Imports decreased following this reduction in duty.

Tariff consideration.—The tariff on mercurial medicinals should be considered in conjunction with the tariff on the raw-material mercury or quicksilver. The mercurial preparations contain as high as from 70 to 85 per cent of mercury.

Calomel, corrosive sublimate, and other mercurial preparations—Imports for consumption—Revenue.

Fiscal year.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	35 per cent	33,166	$19,883	$6,959	$0.599	35.00
1909	do	35,366	21,700	7,595	.614	35.00
1910	do	48,324	32,319	11,311	.669	35.00
1911	do	.....	33,896	11,863	.....	35.00
1912	do	.....	35,842	12,544	.....	35.00
1913	do	.....	42,728	14,954	.....	35.00
1914	do	.....	7,094	2,482	.....	35.00
1914	15 per cent	.....	30,352	4,552	.....	15.00
1915	do	.....	12,920	1,938	.....	15.00
1916	do	.....	13,158	1,973	.....	15.00
1917	do	.....	9,974	1,496	.....	15.00
1918	do	.....	2,124	318	.....	15.00
1919	do	526	915	137	1.74	15.00
1920	do	.....	.....	.....	.....	15.00

Mercurials, prices (wholesale), spot, New York, per pound.

[From Oil, Paint, and Drug Reporter.]

Year.	Corrosive sublimate.	Calomel.		Mercury bisulphate.	Blue mass, United States Pharmacopœia.	Red precipitate.	White precipitate.
		American.	English.				
1912	$0.81–0.84	$0.90–0.92	$1.05–1.15	$0.64–0.66	$0.44–0.46	$1.00–1.10	$1.05–1.10
	.79– .84	.88– .92	1.03–1.07	.62– .66	.44– .46	.96–1.08	1.03–1.08
	.79– .84	.88– .92	1.08–1.10	.62– .66	.44– .46	.98–1.08	1.03–1.08
1913	.79– .85	.88– .92	1.08–1.10	.62– .66	.44– .46	.98–1.08	1.03–1.08
	.76– .82	.85– .89	1.03–1.15	.59– .63	.42– .44	.95–1.05	1.00–1.05
	.76– .82	.85– .89	1.03–1.15	.59– .63	.42– .44	.95–1.05	1.00–1.05
	.71– .77	.80– .85	1.02–1.15	.54– .58	.42– .44	.90–1.00	.95–1.00
1914	.66– .72	.75– .80	1.02–1.05	.49– .53	.42– .44	.85– .95	.90– .95
	.54– .60	.63– .69	1.02–1.05	.37– .41	.40– .44	.73– .83	.78– .83
	.54– .60	.63– .69	1.02–1.05	.37– .41	.40– .44	.73– .83	.78– .83
	.51– .57	.60– .66	.58– .60	.42– .46	.40– .44	.75– .80	.75– .80
	.81– .86	.90– .95	1.25	.72– .74	.57	1.00–1.10	1.05–1.10
1915	.81– .86	.88– .90	1.10–1.25	.72– .74	.57– .58	1.00–1.10	1.05–1.10
	.95	.99–1.00	1.10–1.25	.81– .83	.58– .59	1.09–1.19	1.14–1.19
	1.20	1.35–1.39	1.60–1.65	1.06–1.07	.66– .67	1.41–1.45	1.51–1.55
	1.35	1.40–1.45	1.75–1.80	1.21–1.22	.72– .74	1.56–1.66	1.66–1.71
1916	1.53	1.61–1.62	1.75–1.80	1.39–1.40	.81– .83	1.74–1.84	1.84–1.89
	2.78	3.08	(1)	2.74	1.55–1.57	3.38–3.48	3.48–3.53
	1.28	1.36	.....	1.00	.58– .60	1.49–1.59	1.59–1.64
	1.28	1.36	.....	1.00	.58– .60	1.49–1.59	1.59–1.64
1917	1.29	1.43	.....	1.07	0.60–.62	1.57–1.67	1.67–1.72
	1.61	1.79	.....	1.40	.73–.75	1.97	2.06
	1.71	1.91	.....	1.50	.78	2.10–2.20	2.20–2.25
	1.71	1.91	.....	1.50	.83	2.10–2.20	2.20–2.25
1918	1.71	1.91	.....	1.50	.83	2.10–2.20	2.20–2.25
	1.71	1.91	.....	1.50	.83	2.10–2.20	2.20–2.25
	1.71	1.91	.....	1.50	.83	2.10–2.20	2.20–2.25
	1.79	2.00	.....	1.58	.95	2.19–2.29	2.29–2.39
1919:							
January	1.79	2.00	.....	1.58	.95	2.19–2.29	2.29–2.39
April	1.36	1.51	.....	1.09	.75	1.66	1.80
July	1.43–1.48	1.59	.....	1.17	.78–.80	1.75	1.88–1.93
October	1.58–1.63	1.76	.....	1.34	.84–.86	1.93	2.05–2.10
1920:							
January	1.51–1.56	1.68	.....	1.26	.81–.83	1.85–1.95	1.97–2.02
April	1.42–1.47	1.58	.....	1.16	.77–.79	1.74–1.84	1.87–1.92
July	1.42–1.47	1.58	.....	1.16	.77–.79	1.14	1.87–1.92

[1] English not quoted since about April, 1916.

Mercurials—Rates of duty.

Act of—		Tariff classification or description.	Rates of duty specific and ad valorem.
Year.	Paragraph.		
1890	75	"* * * calomel and other mercurial medicinal preparations"	35 per cent ad valorem.
1894	.....	Not enumerated	
1897	68	"* * * calomel and other mercurial medicinal preparations"	Do.
1909	65	"* * * calomel, corrosive sublimate, and other mercurial medicinal preparations"	Do.
1913	14	"Calomel, corrosive sublimate, and other mercurial preparations".	15 per cent ad valorem.

COURT AND TREASURY DECISIONS.

Mercury sulphocyanate, mercury nitrate, mercurous cryst., mercury oxycyanide, and mercury bichloride were held not to be medicinal preparations within paragraph 68 of the act of 1897 and to be dutiable as chemical compounds under paragraph 3.—G. A. 4909 (T. D. 22970).

Calomel in 1-pound packages was classified under paragraph 17 of the act of 1913, and corrosive sublimate and other mercurial preparations put up in packages of 2½ pounds or less were likewise classified, but such preparations in packages of more than 2½ pounds each were held dutiable under paragraph 14.—Abstract 36156 (T. D. 34668), Abstract 36154 (T. D. 34668).

CHALK.

[Par. 15, act of 1913.]

SUMMARY.

Description and uses.—Chalk is a soft earthy form of calcium carbonate composed almost entirely of the remains of small marine organisms and shells. It is generally of a yellowish or grayish color, though sometimes snow white.

The principal uses are as follows:

(1) As a paint filler when ground into whiting.
(2) For making lime.
(3) Crayons and carpenters' and tailors' chalk.
(4) Pastel work when mixed with coloring materials.
(5) Tooth powders and metal polishes.

Domestic production.—No supply of American chalk of good quality is available for the eastern manufacturing market. Small quantities of an inferior quality are mined in California, Illinois, and Iowa.

Imports.—Normally about 60 per cent of the crude chalk and about 50 per cent of the manufactured chalk imported comes from England. France furnishes nearly 40 per cent of each. During the war the French supply was practically cut off, while the trade with England and Denmark increased. Imports of manufactured chalk have declined from $80,941 in 1913 to $39,526 in 1917.

Exports.—No crude chalk is exported, but the exports of manufactured chalk have increased greatly since 1914.

Prices.—The price of chalk remained practically unchanged from 1910 to 1914, since which time the price of crude chalk has fluctuated, while that of manufactured chalk has advanced about 25 per cent.

Tariff history.—Crude chalk has been on the free list since 1883. Manufactured chalk has been dutiable at either 1 cent per pound or 20 to 25 per cent since 1883. The present rate of duty is 25 per cent.

Chalk—Summary table.

Year.	Domestic production (long tons).	Imports for consumption (value).	Domestic exports (value).	Value[1] (imports for consumption).	Amount of duty.	Value for unit of quantity.	Equivalent ad valorem. rate.
1910	6,531	$176,295.00	$110,647.00	$69,293.00	$27,283.00	.....	$39.37
1911	.....	209,854.00	122,490.00	92,423.00	38,261.00	.....	41.40
1912	.....	217,331.00	56,414.00	88,390.00	38,098.00	.....	43.10
1913	.....	200,880.00	49,478.00	79,731.00	25,366.00	.....	31.81
1914	.....	153,675.00	40,154.00	50,778.00	12,990.00	.....	20.00
1915	.....	127,038.00	51,175.00	[2] 35,849.00	8,961.00	.....	25.00
1916	4,690	141,401.00	60,417.00	45,540.00	11,384.00	.....	25.00
1917	12,229	164,601.00	105,202.00	33,219.00	8,294.75	.....	25.00
1918	.....	164,982.00	186,711.00	42,390.00	9,606.13	.....	[1] 22.66
1919	.....	156,710.00	273,741.00	38,914.00	8,721.13	$1.84	[1] 22.42
1918[3]	.....	153,921.00	.....	40,408.00	8,887.00	.....	21.99
1919[3]	.....	188,804.00	.....	48,190.00	10,712 00.	.....	22.22
1920[4]	.....	140,051.00	.....	32,443.00	2,745.00	.....	8.45

[1] Dutiable only.
[2] Ground or bolted included since 1914.
[3] Imports for calendar year; do not include French chalk.
[4] Six months ending June 30, 1920.

GENERAL INFORMATION.

Description.—Chalk is a natural calcium carbonate rock composed almost entirely of the calcareous remains of small marine organisms and shells. It is fine grained, soft, and earthy, not hard and crystalline in structure like other forms of limestone and marble. It has a wide variation in color, some varieties being almost snow white and others gray or yellowish. It occurs abundantly along the southern coast of England and in the north of France. In some localities it is hard and compact enough to be used as building stone. The purest chalk contains up to 99 per cent calcium carbonate. Silica is always present, and in some cases quartz, feldspar, rutile, zircon, and other minerals occur in varying amounts. Limited quantities of impure chalk are found in certain localities in the United States—California, Iowa, Illinois, Kansas, and some other States.

Uses.—The crude, unpurified chalk has a great variety of uses. Its use as crayons is extensive. Considerable quantities are burned to quick lime and then used for making mortar. Some is used in the manufacture of concrete and plaster, and it is sometimes used as a fertilizer for clayey soils. Chalk is also used in England in the manufacture of sodium carbonate and for producing carbon dioxide in quantity.

The crude chalk may be purified by grinding it to a fine powder and mixing with water. The coarse and heavy material settles quickly, and the water containing the fine suspended matter is then drawn off. This suspended matter is then allowed to settle, completely separated from the water, and dried. This is known as precipitated chalk and has various uses. When very pure, it is used in medicine as an antiacid, also as a very mild astringent. Under the name of "whiting" it is used for tooth powder, as a polisher for glass or metal, and is mixed with linseed oil in making putty.

Whiting is sometimes mixed with other pigments as a filler, but its chief use in paints is for the so-called "water paints," as whitewash and calcimine. "Paris white" is practically the same as whiting and is used in the manufacture of India rubber goods, oilcloth, and wall paper.

Chalk perfectly purified is mixed with vegetable coloring matters; such as tumeric, litmus, saffron, and sapgreen, to form pastel colors, but vegetable colors which contain an acid are changed by it. The artists' Vienna white is purified chalk.

Several mineral compounds which resemble chalk are used as chalk substitutes.

(*a*) Red chalk is an impure, earthy variety of hematite. It is used by carpenters for marking wood. If of fine quality it is used in the manufacture of paint.

(*b*) Black chalk is a soft carbonaceous schist which gives a black streak and can be used for drawing and writing.

(*c*) French chalk is really talc, but sometimes the name is applied to some forms of real chalk.

(*d*) Tailors' chalks and billiard chalks, like red chalk, are not chalks in the technical sense, but earthy hematite or colored clay and used for marking cloth or chalking billiard cues.

In order to have tailors', billiard, and red chalk dutiable as chalk, it was necessary to specifically include them. (See T. D. 23027.)

Domestic production and imports.—Comparatively little chalk is produced in the United States, as the deposits are not of high quality and have not been extensively developed.

Nearly all the chalk used in this country is imported from England and France, with small amounts from other countries. Most of that imported is in the crude form, though some is ground and precipitated before it is sent to this country. It is estimated that the minimum domestic consumption is about 200,000 tons.

In 1914 the United States imported from England 84,361 tons of crude chalk and from France 43,203 tons. By 1917 the imports from France had dropped to 400 tons, but English imports had increased to 127,536 tons. The same year the United States imported 15,262 tons from Denmark. The amount for 1918 was somewhat less than for the previous year.

Some purified chalk is imported, but the amount is small compared to that of the crude chalk. The amount has remained fairly constant since 1914. The quantity of manufactured chalk imported is quite small.

Exports.—The United States exports considerable quantities of manufactured chalk, principally to England and Canada. The value of the exports decreased from 1911 to 1914, after which it increased again, and in 1917 was more than double what it was in 1914. The exports for the fiscal year 1918 amounted to $186,711, a decided increase over the previous year.

Tariff considerations.—The act of 1913 contains the following provisions:

Paragraph 446 (Free list). Chalk, crude, not ground, bolted, precipitated, or otherwise manufactured.

Paragraph 15 (Schedule A). Chalk, precipitated, suitable for medical or toilet purposes; chalk put up in the form of cubes, blocks, sticks, or disks, or otherwise, including tailors', billiard, red, and other manufactures of chalk not specially provided for in this section, 25 per cent ad valorem.

Paragraph 60 (Schedule A). Whiting and Paris white, dry, and chalk ground or bolted, $\frac{1}{10}$ cent per pound; whiting and Paris white ground in oil, or putty, 15 per cent ad valorem.

Paragraph 69 (Schedule A) provides for "French chalk," which is not chalk at all, but talc.

It is suggested that the following be substituted for the provisions quoted:

Paragraph — (Free list). Same as paragraph 446.

Paragraph — (Schedule A). Whiting and Paris white, dry, ground in oil, or putty; chalk precipitated, ground, bolted, or put up in the form of cubes, blocks, sticks, or disks, or otherwise, including tailors', billiard, red, and other manufactures of chalk, not specially provided for in this section.

The following table shows the rate of duty of each kind of chalk under the acts of 1909 and 1913. The equivalent ad valorem rate for the fiscal year 1913 under the act of 1909 and the fiscal year 1914 under the act of 1913 are also shown. The ad valorem figure is left blank under chalk, ground or bolted, for 1913, since the official amounts recorded are negligible (the goods being classified under "Whiting").

	Act of 1909.		Act of 1913.	
	Legal rate.	Equivalent ad valorem, 1913.	Legal rate.	Equivalent ad valorem rate.
Crude	Free		Free	
Whiting and Paris white, dry	¼ cent per pound	63 per cent	⅛ cent per pound	27 per cent.
Whiting and Paris white in oil	½ cent	20.68 per cent	15 per cent	15 per cent.
Chalk, ground or bolted	1 cent	31.8 per cent	⅛ cent	
Chalk, precipitated	do	do	25 per cent	25 per cent.
Manufactures, n. s. p. f.	25 per cent	25 per cent	do	Do.

Ground chalk, whiting, and Paris white are merely grades of the same material—natural chalk, ground, washed and bolted. The quality and price is quite variable and dependent on the purity, color, fineness, and freedom from grit.

Precipitated chalk is an artificially prepared product made by chemical means. Precipitated chalk can be secured free from grit and in a finely divided condition more easily and perfectly than the natural chalk and it is therefore preferred for toilet and medicinal purposes.

In the act of 1909 ground chalk and precipitated chalk were put together in paragraph 13 and made dutiable at 1 cent per pound, whereas whiting and Paris white was dutiable at one-fourth cent per pound under paragraph 54. The act of 1913 recognized the essential identity of ground chalk and whiting by placing them together in paragraph 60 dutiable at one-tenth cent per pound but left "precipitated chalk, suitable for medicinal or toilet purposes" in paragraph 15 dutiable at 15 per cent ad valorem. Although it is possible to form a judgment of quality, and therefore of price, based upon the fineness, color, and purity, there is no known method, macroscopic, microscopic, or chemical to determine with certainty the method of manufacture from the examination of the sample. It is therefore suggested that all varieties of chalk—ground, bolted, and precipitated—and whiting and Paris white be placed together in the same paragraph at the same rate of duty. The best commercial grades are worth more than five times as much as the poorest and therefore the rate should be an ad valorem rate instead of a specific rate.

Although no statistics of production in the United States are available it is known that American manufacture is based almost entirely on imported crude chalk and that imports of whiting and precipitated chalk are less than 2 per cent of the imports of crude chalk.

"*Whiting or Paris white ground in oil or putty.*"—Putty is whiting ground in oil, usually linseed oil. Linseed oil is dutiable at 10 cents per gallon, or about 1.3 cents per pound (equivalent to about 20 per cent at normal prices), and whiting at one-tenth cent per pound. The duty of one-half cent per pound under the act of 1909 and 15 per cent under the act of 1913 have been almost prohibitory.

Manufactures of chalk.—"Chalk put up in the form of cubes, blocks, sticks, or disks, or otherwise, including tailors', billiard, red, and other manufactures of chalk not specially provided for in this section."

The imports of manufactured chalk are not large and the duty seems to be sufficient to protect American manufacturers.

Chalk—Production in United States.

	Long tons.
1910	6,531
1916	4,690
1917	12,229

Chalk—Production in principal foreign countries.

[United Kingdom, Mines and Quarries, Part IV, Colonial and Foreign Statistics.]

Countries.	1908	1909	1910	1911
	Tons.	*Tons.*	*Tons.*	*Tons.*
France	79,597	71,699	59,480	61,159
England	4,772,929	4,969,306	5,187,153	5,470,049

Chalk, unmanufactured—Imports by countries—Fiscal years.

Imported from—	1910		1911		1912	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Belgium	3,397	$2,507	446	$445	2,925	$1,916
Denmark					5	47
France	32,761	26,719	40,464	38,223	51,089	46,859
England	79,891	74,554	82,423	78,340	97,792	79,138
All other	16	62	59	650	57	230
Total	116,065	103,842	123,392	117,658	151,868	128,190

Imported from—	1913		1914		1915	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Belgium	400	$419	1,245	$1,073	15	$46
Denmark	1,015	594				
France	56,305	43,844	43,203	34,865	16,525	12,619
England	91,580	71,364	84,361	66,746	104,506	77,469
All other	1,709	3,828	33	223	1,180	1,054
Total	151,009	120,049	128,842	102,907	122,226	91,188

Imported from—	1916		1917		1918	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Denmark	11,239	$8,232	15,262	$15,820	6,500	$9,185
France			400	291		
England	120,129	87,629	127,536	115,271	100,284	112,740
All other	98	774		3	607	667
Total	131,466	96,635	143,198	131,385	107,391	122,592

Chalk, unmanufactured (free)—Imports by countries—Calendar years.

Imported from—	1918		1919		1920 [1]	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Denmark	2,000	$2,190	4,407	$4,644		
England	80,855	108,261	93,057	135,356		
Canada	1,078	3,534				
Japan			505	614		
Total	83,933	113,985	97,969	140,614	124,863	$197,894

[1] 10 months ending Oct. 31, 1920, not stated by countries.

Chalk, ground, precipitated, etc.—Imports by countries—Fiscal years.

Imported from—	1910	1911	1912	1913	1914	1915
Austria-Hungary	$4,037	$5,304	$4,675	$7,909	$2,677	$1,200
France	10,105	6,372	8,191	7,124	5,330	2,732
Germany	18,258	31,969	27,154	26,740	12,213	5,224
England	36,645	41,302	43,626	33,996	30,385	25,709
North America	1,059	2,593	131	98	170	58
All other	3,086	4,921	5,062	5,074	2,843	1,384
Total	73,190	92,461	88,839	80,941	53,618	36,307

Imported from—	1916	1917	1918	1918 [1]	1919 [1]	1920 [2]
Austria-Hungary	$782	.....	.....	.....	$364	.....
France	2,614	$4,377	$7,961	$5,028	236	.....
Germany	385	.....	.....	.....	.....	.....
England	41,777	29,256	34,498	35,623	47,716	.....
North America	2	707	117	3	305	.....
Italy	.....	.....	.....	.....	637	.....
Switzerland	.....	.....	.....	10	66	.....
Japan	.....	.....	.....	10	401	.....
All other	575	[3] 5,186	246	.....	.....	.....
Total	46,135	39,526	42,822	40,674	49,725	$71,955

[1] Calendar years. [2] 10 months ending Oct. 31, 1920. [3] Sweden, $5,167.

Chalk, crude, not ground, bolted, precipitated, or otherwise manufactured—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Value per unit of quantity.
Fiscal years:		*Tons.*		
1907	Free	91,846	$85,503	$0.931
1908	do	125,871	113,587	.902
1909	do	96,311	93,451	.970
1910	do	116,115	103,847	.894
1911	do	123,278	117,041	.949
1912	do	151,868	128,190	.844
1913	do	150,010	120,049	.800
1914	do	128,947	102,907	.798
1915	do	120,225	91,188	.758
1916	do	131,368	95,861	.729
1917	do	143,216	131,385	.917
1918	do	107,391	122,592	1.141
1919	do	84,539	117,796	1.393
Calendar years:				
1918	do	83,933	113,985	1.358
1919	do	97,969	140,614	1.435
1920 [1]	do	66,094	107,608	1.628

[1] Six months ending June 30, 1920.

Chalk, precipitated, suitable for medicinal or toilet purposes, etc.[1]*—Imports for consumption—Revenue.*

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	1 cent per pound	329,969	$7,653	$3,300	$0.023	43.12
1908	do	709,967	22,526	7,099	.032	31.52
1909	do	1,363,005	32,225	13,634	.024	42.31
1910	do	2,728,382	69,293	27,283	.025	39.37
1911	do	3,826,118	92,423	38,261	.024	41.40
1912	do	3,809,841	88,390	38,098	.023	43.10
1913	do	2,536,621	79,731	25,366	.031	31.81
1914	do	485,771	18,235	4,857	.038	26.64
1914[2]	25 per cent	([3])	32,288	8,072		25.00
1915	do	([3])	35,499	8,874		25.00
1916	do	([3])	45,288	11,321		25.00
1917	do	([3])	33,141	8,284		25.00
1918	do	([3])	37,258	9,314		25.00
1919	do	1,175,783	33,462	8,366	.028	25.00
Calendar years:						
1918	do	([3])	29,263	7,315		25.00
1919	do	1,349,538	38,610	9,652	.029	25.00
1920[5]	do	226,133	[4] 4,977 6,283	1,244 1,571	.027	25.00

[1] Prior to 1914 items shown did not include chalk for medicinal or toilet purposes.
[2] Amounts shown after Oct. 4, 1913, include precipitated chalk suitable for medicinal or toilet purposes and chalk in cubes, sticks, etc., including tailors', billiard, and red.
[3] Quantity not shown.
[4] Amount for tailors', billiard, and red, quantity not shown.
[5] Six months.

Chalk, ground or bolted—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914	$\frac{1}{10}$ cent per pound	4,312	$446	$4	$0.103	0.97
1915	do	56,882	474	56	.008	12.00
1916	do	136	12		.088	1.17
1917	do	1,181,755	5,867	1,184	.005	20.19
1918	do	195,776	4,679	195	.024	4.18
1919	do	177,912	4,675	178	.026	3.81
1920	do					
Calendar years:						
1918		241,752	5,829	242	.024	4.15
1919		229,920	6,260	230	.027	3.67
1920[1]	$\frac{1}{10}$ cent per pound	823,391	20,754	823	.025	3.96

[1] Six months ending June 30, 1920.

Talcum, ground talc, steatite, and French chalk, cut, powdered, washed, or pulverized—Imports for comsumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:[1]		*Pounds.*				*Per cent.*
1914	15 per cent		$1,687	$253		15
1915	do		278	41		15
1916	do		583	87		15
1917	do		233	34		15
1918	do		174	26		15
1919[2]	do	2,240	128	19	$0.057	15
Calendar years:						
1918	do	25,469,657	[3] 266 251,323	40 37,698		15
1919	do	25,922,506	[3] 323 248,576	48 37,286		15
1920[4]	do	20,859,409	212,176	31,826	.0101	15

[1] Figures for fiscal years are for French chalk only.
[2] Quantity not previously shown.
[3] Amount of imports of French chalk. French chalk is not stated separately for 1920.
[4] Six months ending June 30, 1920.

Chalk, other manufactures of—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	25 per cent		$39,218	$9,805		25
1908	do		13,487	3,371		25
1909	do		12,346	3,086		25
1910	do		3,155	788		25
1911	do		390	97		25
1912	do		751	187		25
1913	do		1,100	275		25
1914	do		245	61		25
1915	do		350	87		25
1916	do		252	63		25
1917	do		78	19		25
1918	do		279	69		25
1919	do	1,852	649	162	$0.350	25
1920	do					25
Calendar years:						
1918	do	(1)	629	157		25
1919	do	2,909	325	81	.111	25
1920 [2]	do	(1)	429	107		25

[1] Quantity not shown. [2] Six months ending June 30, 1920.

Whiting and paris white, dry—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	½ cents per pound	1,858,339	$13,219	$4,646	$0.007	35.15
1908	do	2,399,082	11,467	5,997	.005	52.30
1909	do	2,089,981	13,540	5,224	.006	38.59
1910	do	2,868,239	16,305	7,170	.006	43.98
1911	do	4,656,958	18,758	11,642	.004	62.07
1912	do	3,729,155	14,578	9,322	.004	63.95
1913	do	3,536,747	14,032	8,841	.004	63.01
1914	do	286,715	2,644	716	.009	27.10
1914	1/10 cent per pound	2,074,890	7,809	2,074	.004	26.57
1915	do	5,387,038	15,705	5,387	.003	34.30
1916	do	3,655,123	14,459	3,655	.004	25.28
1917	do	2,147,895	11,292	2,147	.005	19.02
1918	do	4,908,295	31,033	4,908	.006	15.82
1919	do	586,780	5,097	587	.009	11.52

Whiting and paris white, ground in oil (putty)—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	1 cent per pound	3,519	$114	$35	$0.032	30.77
1908	do	132	6	1	.045	22.00
1909	do	76	7		.094	
1910	do	1,079	73	10	.068	14.78
1910	½ cent per pound	16,916	147	84	.009	57.54
1911	do	77,581	1,151	387	.015	33.69
1912	do	29,047	866	145	.030	16.77
1913	do	36,434	881	182	.024	20.68
1914	do	14,810	276	74	.019	26.81
1914	15 per cent	22,210	635	95	.029	15.00
1915	do	18,078	343	51	.019	15.00
1916	do	16,082	386	57	.024	15.00
1917	do	33,286	1,472	220	.044	15.00
1918	do	36,398	3,781	567	.104	15.00
1919	do	4,635	821	123	.177	15.00
1920	do					
1921	do					

Chalks—Domestic exports.

FISCAL YEAR.

Exported to—	1910	1911	1912	1913	1914	1915
Germany	$1,063	$2,602	$194	$455	$1,448	$16
Netherlands	4,360	4,105	5,569	1,963	1,620	.....
United Kingdom	39,746	43,769	17,346	26,180	18,492	31,137
Canada	22,730	19,783	14,799	2,165	17	461
Mexico	3,408	6,320	450	670	860	542
South America	5,212	8,963	5,422	5,261	3,009	7,352
Oceania	12,833	20,664	3,453	7,074	8,615	6,869
All other	21,295	16,284	9,181	5,910	6,093	4,798
Total	110,647	122,490	56,414	49,478	40,154	51,175

Exported to—	1916	1917	1918
Germany	.....	.....	.....
Netherlands	$36	.....	.....
United Kingdom	23,268	$27,664	$14,560
Canada	12,872	36,642	71,664
Mexico	1,198	3,961	7,230
South America	8,521	9,218	35,704
Oceania	4,338	13,071	16,564
All other	10,184	14,646	40,989
Total	60,417	105,202	186,711

CALENDAR YEARS.

Exported to—	1918	1919	1920[1]
United Kingdom	$2,903	$41,737	.....
Canada	75,115	71,860	.....
Mexico	8,913	23,301	.....
Cuba	6,634	14,112	.....
Argentina	9,732	14,691	.....
Chile	10,752	8,918	.....
Australia	8,075	18,359	.....
All other	50,041	140,695	.....
Total	172,165	333,673	$366,400

[1] 10 months ending Oct. 31, 1920, not stated by countries.

Chalk, precipitated, light, casks, prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Year.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.
1910	4½–6	4½–6	4½–6	4½– 6
1911	4½–6	4½–6	4½–6	4½– 6
1912	4½–6	3½–4½	4 –4½	4 – 4½
1913	4 –4½	4 –4½	4 –4½	4 – 4½
1914	4 –4½	4 –4½	4 –4½	[1] 8 –10
1915	4½–5½	4½–5½	4½–5½	4½– 5½
1916	4½–5½	4½–5½	4½–5½	4½– 5½
1917	4½–5½	4½–5½	4½–5½	4½– 5½
1918	5½–6	4¾–5	4¾–5	4¾– 5
1919	5 –6	5 –6	5 –6	5 – 6
1920	5⅝–6⅝	4½–5	5½–6	5½– 6

[1] Temporary, due to early war conditions.

Chalk, precipitated, heavy, prices per pound, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Year.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.
1910	3 -3½	3 -3½	3 -3½	3 -3½
1911	3 -3½	3 -3½	3 -3½	3 -3½
1912	3 -3½	3 -3½	3 -3½	3 -3½
1913	3 -3½	3 -3½	3 -3½	3 -3½
1914	3 -3½	3 -3½	3 -3½	7 -8
1915	4 -5	4 -5	4 -6	4 -6
1916	5 -6	4 -5	4 -6	4 -6
1917	3½-5	3½-5	3½-5	3½-5
1918	3½-5	3½-5	3½-5	3½-5
1919	5½-6	5½-6	5½-6	4½-5
1920	5 -6	3½-4	4½-5	4½-5

Chalk, English, prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Year.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.	Aug. 1.
1911	$2.75	$2.75	$2.75	$2.75	.....
1912	$2.80- 2.85	$2.70- 3.05	$2.70- 3.05	$2.70- 3.05	.....
1913	4.00- 3.05	3.75	2.75- 3.00	2.75- 3.00	.....
1914	2.75- 3.00	2.75- 3.00	2.75- 3.00	2.75- 3.00	$2.75-$3.00
1915	3.50	3.50	4.00	(1)	.....
1916	(1)	(1)	(1)	(1)	.....
1917	(1)	(1)	(1)	(1)	.....
1918	(1)	(1)	(1)	(1)	.....
1919	(1)	(1)	(1)	(1)	.....
1920	(1)	(1)	(1)	(1)	.....

[1] Nominal.

Chalk, French, prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Years.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.
1910	$3.00-$3.40	$3.00-$3.40	$3.00-$3.40	$3.00-$3.40
1911	3.05	3.05	3.05	3.05
1912	3.05- 3.10	3.05- 3.10	3.05- 3.10	3.05- 3.10
1913	4.25- 3.10	3.00- 4.00	3.10- 3.50	3.10- 3.50
1914	3.10- 3.50	3.10- 3.50	3.10- 3.50	3.10- 3.50
1915	Nominal.	Nominal.	Nominal.	Nominal.
1916	Nominal.	Nominal.	Nominal.	Nominal.
1917	Nominal.	Nominal.	Nominal.	Nominal.
1918	Nominal.	Nominal.	Nominal.	Nominal.
1919	Nominal.	Nominal.	Nominal.	Nominal.
1920	Nominal.	Nominal.	Nominal.	Nominal.

Whiting, commercial, prices per 100 pounds, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Years.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.	Aug. 1.	Lowest.	Highest.
1910	$0.45-$0.50	$0.45-$0.50	$0.45-$0.50	$0.45-$0.50	.....	$0.45	$0.50
1911	.45- .50	.45- .50	.45- .50	.45- .50	.....	.45	.50
1912	.42- .50	.42- .50	.42- .50	.42- .50	.....	.42	.50
1913	.45- .50	.45- .50	.45- .50	.45- .50	.....	.45	.50
1914	.45- .50	.45- .50	.45- .50	.45- .50	$0.45-$0.50	.45	.50
1915	.45- .50	.45- .50	.45- .50	.50- .55	.....	.45	.55
1916	.50- .55	.60- .65	.70- .75	.90	.....	.50	.90
1917	.95	.95	1.25	1.25	.....	.95	1.25
1918	1.10	1.25	1.25	1.25	.....	1.10	1.25
1919	1.25	1.25	1.15- 1.20	1.15- 1.20	.....	1.15	1.25
1920	1.15- 1.20	1.15- 1.20	1.40	1.40	.....	1.15	1.40

O. p. d. r., p. 29 for 1915 and 1917 market.

Whiting, gilders', prices per 100 pounds, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Years.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.	Aug. 1.	Lowest.	Highest.
1910	$0.52–$0.64	$0.52–$0.64	$0.52–$0.64	$0.52–$0.64		$0.52	$0.64
1911	.52– .64	.52– .64	.52– .64	.52– .64		.52	.64
1912	.52– .64	.52– .64	.52– .64	.50– .64		.52	.64
1913	.55– .65	.55– .65	.55– .65	.55– .65		.55	.65
1914	.55– .65	.55– .65	.55– .65	.55– .65	$0.55–$0.65	.55	.65
1915	.55– .65	.55– .65	.55– .65	.60– .65		.55	.65
1916	.60– .65	.70– .75	.80– .85	1.08		.60	1.08
1917	1.15	1.15	1.35	1.35		1.15	1.35
1918	1.25– 1.30	1.30– 1.35	1.30– 1.35	1.30– 1.35		1.25	1.35
1919	1.30– 1.35	1.30– 1.35	1.20– 1.25	1.20– 1.25		1.20	1.35
1920	1.20– 1.25	1.20– 1.25	1.45	1.45		1.20	1.45

Whiting, extra gilders', prices per 100 pounds, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Years.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.	Aug. 1.	Lowest.	Highest.
1910	$0.56–$0.68	$0.56–$0.68	$0.56–$0.68	$0.56–$0.68		$0.56	$0.68
1911	.56– .68	.56– .68	.56– .68	.56– .68		.56	.68
1912	.56– .68	.56– .68	.56– .68	.55– .68		.55	.68
1913	.55– .68	.55– .68	.55– .68	.55– .68		.55	.68
1914	.55– .68	.55– .68	.55– .68	.55– .68	$0.55–$0.68	.55	.68
1915	.55– .68	.55– .68	.55– .68	.65– .70		.55	.70
1916	.65– .70	.75– .80	.85– .90	1.15		.65	1.15
1917	1.25	1.25	1.45	1.45		1.25	1.45
1918	1.40	1.35– 1.50	1.35– 1.50	1.35– 1.50		1.35	1.50
1919	1.35– 1.50	1.35– 1.50	1.30– 1.40	1.30– 1.40		1.30	1.50
1920	1.30– 1.40	1.30– 1.40	1.55	1.55– 1.60		1.30	1.60

Whiting, American Paris white, prices per 100 pounds, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.	August.	Lowest.	Highest.
1910	$0.64–$0.75	$0.64–$0.75	$0.64–$0.75	$0.64. $0.75		$0.64	$0.75
1911	.64– .75	.64– .75	.64– .75	.64– .75		.64	.75
1912	.64– .75	.64– .75	.64– .75	.64– .75		.64	.75
1913	.70– .75	.70– .75	.70– .75	.70– .75		.70	.75
1914	.70– .75	.70– .75	.70– .75	.70– .75	$0.70–$0.75	.70	.75
1915	.70– .75	.70– .75	.70– .75	.70– .75		.70	.75
1916	.70– .75	.70– .75	.80– .85	1.15		.70	1.15
1917	1.25	1.25	2.50– 2.75	2.50– 2.75		1.25	2.75
1918	1.75– 2.75	1.75– 2.75	1.50– 1.75	1.50– 1.75		1.75	2.75
1919	1.50– 1.75	1.50– 1.75	1.50– 1.75	1.50– 1.75		1.50	1.75
1920	1.50– 1.75	1.50– 1.75	1.75	1.75		1.50	1.75

Whiting, English cliffstone, prices per 100 pounds, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

Years.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.	August.	Lowest.	Highest.
1910	$0.75–$0.90	$0.75–$0.90	$0.75–$1.10	$0.75–$ .10		$0.75	$1.10
1911	.75– 1.10	.75– 1.10	.75– 1.10	.75– 1.10		.75	1.10
1912	.75– 1.10	.75– 1.10	.75– 1.10	.75– 1.10		.75	1.10
1913	.75– 1.10	.75– 1.10	.75– 1.10	.75– 1.10		.75	1.10
1914	.75– 1.10	.75– 1.10	.75– 1.10	.75– 1.10	$0.75–$1.10	.75	1.10
1915	.75– 1.10	.75– 1.10	.75– 1.10	.75– 1.10		.75	1.10
1916	.75– 1.10	1.00– 1.50	1.00– 1.50	1.25– 1.60		.75	1.60
1917	1.50– 1.80	1.50	1.50– 1.80	1.50– 1.80		1.50	1.80
1918	1.50– 1.75	1.50– 1.75	1.75– 2.75	1.75– 2.75		1.50	2.75
1919	1.75– 2.75	1.75– 2.75	1.75– 2.50	1.75– 2.50		1.75	2.50
1920	1.75– 2.50	1.75– 2.50	2.00	2.00		1.75	2.50

Rates of duty.

CHALK.

Act of— Year.	Act of— Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	46	Prepared chalk, precipitated chalk, French chalk, red chalk, and all other chalk preparations which are not specially enumerated or provided for in this act.	20 per cent ad valorem.
1890	16	Chalk, prepared, precipitated, French, and red, all other chalk preparations not specially provided for in this act.	1 cent per pound. 20 per cent ad valorem.
	531	Chalk, unmanufactured	Free.
1894	11	Chalk, prepared, precipitated, French, red, and all other chalk preparations not specially provided for in this act.	20 per cent ad valorem.
	433	Chalk, unmanufactured	Free.
1897	13	Chalk (not medicinal nor prepared for toilet purposes) when ground, precipitated, naturally or artificially, or otherwise prepared, whether in the form of cubes, blocks, sticks or discs, or otherwise, including tailors', billiard, red, or French chalk.	1 cent per pound.
		Manufactures of chalk not specially provided for in this act	25 per cent ad valorem.
	519	Chalk, crude, not ground, precipitated, or otherwise manufactured.	Free.
1909	13	Chalk, when ground, bolted, precipitated, naturally or artificially, or otherwise prepared, whether in the form of cubes, blocks, sticks, or discs, or otherwise, including tailors', billiard, red, or French chalk.	1 cent per pound.
		Manufactures of chalk not specially provided for in this section	25 per cent ad valorem.
	531	Chalk, crude, not ground, bolted, precipitated, or otherwise manufactured.	Free.
1913	15	Chalk, precipitated, suitable for medicinal or toilet purposes; chalk put up in the form of cubes, blocks, sticks, or discs, or otherwise, including tailors', billiard, red, and other manufactures of chalk not specially provided for in this section.	25 per cent ad valorem.
1913	446	Chalk, crude, not ground, bolted, precipitated, or otherwise manufactured.	Free.
	60	* * * Chalk, ground or bolted	1/10 cent per pound.

WHITING AND PARIS WHITE.

1883	45	Whiting and Paris white, dry	½ cent per pound.
		Ground in oil or putty	1 cent per pound.
1890	59	Whiting and Paris white, dry	½ cent per pound.
		Ground in oil or putty	1 cent per pound.
1894	46	Whiting and Paris white, dry	½ cent per pound.
		Ground in oil or putty	½ cent per pound.
1897	56	Whiting and Paris white, dry	½ cent per pound.
		Ground in oil or putty	1 cent per pound.
1909	54	Whiting and Paris white, dry	½ cent per pound.
		Ground in oil or putty	½ cent per pound.
1913	60	Whiting and Paris white, dry	1/10 cent per pound.
		Whiting and Paris white, ground in oil or putty	15 per cent ad valorem.

COURT AND TREASURY DECISIONS.

Precipitated chalk used in the manufacture of tooth powder, and, to a less extent, of explosives and paints, and which sometimes is bolted, has been held dutiable as bolted chalk on the ground that it was not suitable in its imported condition for medicinal or toilet purposes. (G. A. 8144, T. D. 37569 (1918), following United States *v.* Anderson, 175 Fed. 961, holding that chalk merely precipitated artificially, bolted, and packed in bags was not within the exception in the act of 1897 (par. 13) for "chalk prepared for toilet purposes;" also U. S. *v.* Amerman, 9 Ct. Cust. Appls., 244, of 1919.)

The provision for "chalk, crude," has been interpreted not to include so-called "red chalk, in lumps," used for the marking of lumber. The chalk exempted from duty was declared to be white or grayish white, and a carbonate of lime or natural form of calcium carbonate used in medicinal preparations and toilet articles. (Abstract 36905, T. D. 34933 (1914); G. A. 4920, T. D. 23027 (1901).)

French chalk was also held to be excluded. (Abstract 35897, T. D. 34571 (1914); American Lava Co. *v.* United States, 3 Ct. Cust. Appls., 522.)

A heavy precipitated chalk, ground ready for use in the manufacture of tooth powder, was held dutiable under paragraph 13 of the act of 1909 and not exempt from duty as "cliff-stone" under paragraph 683. (Abstract 35896, T. D. 34571 (1914).)

Carbonate of strontia held not dutiable as chalk under paragraph 11 of the act of 1894. (G. A. 3572, T. D. 17624 (1896).)

A powder put up in small packages for use by jewelers in polishing metals, and composed of more than 93 per cent of carbonate of lime was held to be dutiable as whiting under the act of 1894 and not as an article composed of earthy or mineral substances, n. s. p. f. (United States *v.* Tiffany, 117 Fed. 367 (1902).)

Metal polishes composed of little lime and considerable silica have been classified as whiting by similitude and otherwise, under the act of 1909, according to the facts in the particular case. (Bartley *v.* United States, 3 Ct. Cust. Appls., 363; United States *v.* Holland, etc., 4 Ct. Cust. Appls., 336; Kreamer *v.* United States, 4 Ct. Cust. Appls., 433, 437; Wanamaker *v.* United States, 6 Ct. Cust. Appls., 21.)

ALCOHOLIC PREPARATIONS.

[Par. 16, act of 1913.]

General Information.

The purpose of this paragraph is to impose higher import duties on all chemical and medicinal compounds and preparations containing alcohol than on those not containing alcohol to compensate for the fact domestic manufacturers of such preparations must pay a heavy internal-revenue tax on alcohol. However, since the passage of the act of 1913 there have been increases in the internal-revenue taxes on alcohol so that the extra import duties levied by the act of 1913 are no longer in proportion to the present internal-revenue taxes.

Medicinal compounds, preparations, mixtures, and salts containing alcohol—Imports for consumption—Revenue.

CONTAINING MORE THAN 20 PER CENT AND NOT MORE THAN 50 PER CENT OF ALCOHOL.

[Under general tariff.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1914	20 cents per pound plus 20 per cent.	14,056	14,135	5,638	1.01	39.89
1915	do	5,131	6,618	2,349	1.28	35.51
1916	do	5,389	6,146	2,307	1.14	37.54
1917	do	4,115	6,202	2,063	1.50	33.27
1918	do	66,000	26,002	18,400	3.93	70.77
Calendar year:						
1918	do	144,661	120,986	53,129	.84	43.91
1919	do	112,978	42,535	31,102	.38	73.12

CONTAINING MORE THAN 50 PER CENT OF ALCOHOL.

[Under general tariff.]

Fiscal year:						
1914	40 cents per pound plus 20 per cent.	3,282	3,909	2,094	1.19	53.57
1915	do	2,978	4,328	2,056	1.45	47.52
1916	do	2,234	3,226	1,538	1.44	47.70
1917	do	2,938	3,613	1,898	1.22	52.53
1918	do	27,815	10,789	13,284	.38	123.12
Calendar year:						
1918	do	26,592	11,446	12,926	.43	112.93
1919	do	106,276	31,454	48,801	.30	155.15

Medicinal preparations containing alcohol or in the preparation of which alcohol is used (Acts of 1897 and 1909.)

[Under general tariff.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1908	55 cents per pound	192,796	178,192	106,089	0.924	59.50
1909[1]	do	6,096	1,756	3,352	.288	19.09
1910	do	171,247	152,658	94,186	.891	61.70
1911	do	157,661	138,542	86,714	.879	62.59
1912	do	117,101	109,254	64,406	.933	58.95
1913	do	115,925	114,933	63,758	.991	55.49
1914	do	19,833	22,399	10,908	1.129	48.70

[1] Chloral hydrate.

FROM CUBA (RECIPROCITY TREATY, DEC. 27, 1903).

Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1908	55 cents per pound less 20 per cent.	177	135	78	0.763	57.64
1909	do	543	427	289	.787	55.94
1910	do	94	76	41	.812	54.22
1911	do	52	40	22	.776	56.71
1912	do	848	465	373	.549	80.17
1913	do	136	72	59	.529	83.11

Medicinal compounds, preparations, mixtures, and salts, containing alcohol. (Act of 1913.)

CONTAINING 20 PER CENT OF ALCOHOL OR LESS.

[Under general tariff.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Average ad valorem rate.
Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1914	10 cents per pound plus 20 per cent.	67,043	100,646	26,833	1.50	26.67
1915	do	72,303	94,912	26,212	1.31	27.62
1916	do	62,866	66,941	19,674	1.06	29.39
1917	do	53,617	71,462	19,654	1.33	27.50
1918	do	57,064	63,579	18,422	1.11	28.98
Calendar years:						
1918	do	49,940	56,773	16,349	1.13	28.80
1919	do	58,236	113,836	28,591	1.95	25.12

FROM CUBA (RECIPROCITY TREATY, DEC. 27, 1903).

Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1914	10 cents per pound plus 20 per cent less 20 per cent.	50	35	9	0.70	27.43
1915	do	497	271	83	.54	30.67
1916	do	452	273	79	.60	29.25
1917	do	54	31	9	.57	29.94
1918	do	225	172	45	.76	26.47
Calendar years:						
1918	do	291	189	54	.65	28.32
1919	do	353	241	67	.68	27.72

Chemical compounds, mixtures, and salts containing alcohol or in the preparation of which alcohol is used. (Act of 1909.)

[Under general tariff.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1910	55 cents per pound	28,896	25,874	15,893	0.895	61.43
1911	do	19,464	18,547	10,705	.953	57.72
1912	do	42,479	46,465	23,363	1.093	50.27
1913	do	26,324	31,105	14,478	1.181	46.54
1914	do	4,361	2,724	2,398	.624	88.07

Chemical compounds, mixtures, and salts on which the specific duty does not amount to to 25 per cent. (Act of 1909.)

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1910	25 per cent	14,967	5,550	1,387	0.371	25.00
1911	do	327	782	195	2.391	25.00
1912	do	42,137	2,986	746	.071	25.00
1913	do	340	1,828	457	5.376	25.00
1914	do	3,188	431	107	.135	25.00

Chemical compounds, preparations, mixtures, and salts, containing alcohol, or in the preparation of which alcohol is used. (Act of 1913.)

CONTAINING 20 PER CENT OF ALCOHOL OR LESS.

[Under general tariff.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1914	10 cents per pound plus 20 per cent.	18,391	26,061	7,051	1.42	27.06
1915	do	11,320	15,533	4,238	1.37	27.29
1916	do	4,384	23,910	5,220	5.45	21.83
1917	do	10,905	27,544	6,589	2.54	23.92
1918	do	8,156	30,387	6,893	3.72	22.68
Calendar years:						
1918	do	5,023	25,055	5,513	4.99	22.00
1919	do	1,187	2,662	651	2.24	24.46

CONTAINING MORE THAN 20 PER CENT AND NOT MORE THAN 50 PER CENT OF ALCOHOL.

Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1914	20 cents per pound plus 20 per cent.	1,904	1,844	749	0.968	40.65
1915	do	290	283	114	.975	40.39
1916	do	1,377	1,453	566	1.055	38.95
1917	do	789	1,273	412	1.613	32.40
1918	do	23,915	15,382	7,859	.643	51.09
Calendar years:						
1918	do	25,921	9,763	7,137	.376	73.10
1919	do	171	950	224	5.556	23.60

Chemical compounds, preparations, mixtures, and salts, containing alcohol, or in the preparation of which alcohol is used. (*Act of 1913*)—Continued.

CONTAINING MORE THAN 50 PER CENT OF ALCOHOL.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad-valorem rate.
Fiscal years:		*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1914	40 cents per pound plus 20 per cent.	2,798	4,487	2,016	1.603	44.95
1915	do	955	847	551	.886	65.10
1916	do	256	244	151	.953	61.97
1917	do	344	1,556	448	4.523	28.84
1918	do	1,349	850	709	.630	83.48
Calendar years:						
1918	do	2,469	1,185	1,225	.480	103.34
1919	do	591	308	298	.521	96.75

Court and Treasury Decisions.

The terms "chemical compound" and "chemical mixture" are distinguished and the term "medicinal preparations" is defined under paragraph 5 (supra). The oils are described under paragraphs 44, 45, and 46, and the ethers under paragraph 29 (infra).

Certain so-called *Chinese wines*, possessing medicinal properties and handled in the drug trade, are dutiable under this paragraph as medicinal preparations containing alcohol. (T. D. 37212, of 1917 and 37849, of 1918.)

The term "alcoholic compounds" is used in a common or broad sense of being any union or mixture of elements, ingredients, or parts, such as finely cut herbs commingled with alcohol and constituting to some degree an infusion. (175 Fed., 33, of 1909.)

SMALL PACKAGE ARTICLES.

[Par. 17, act of 1913.]

GENERAL INFORMATION.

Imports under paragraph 17 in packages of 2½ pounds or less from 1914, when first shown, to 1918, inclusive, have been valued between $455,491 and $711,016 per year, and have yielded a yearly revenue varying from $91,357 to $142,203. Imports in the form of capsules, etc., amounted to $800,000 in both 1914 and 1915, and yielded a yearly revenue of about $200,000. In 1918 imports decreased to $443,210, yielding a revenue of $110,803.

Chemical and medicinal compounds, combinations, and all similar articles (except soap) in individual packages of 2½ pounds or less, gross weight, dutiable at not less than 20 per cent. (Act of 1913.)

[Under general tariff.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Average ad valorem rate.
Fiscal year:						*Per cent.*
1914	20 per cent		$604,558	$120,917		20.00
1915	do		711,016	142,203		20.00
1916	do		455,491	91,098		20.00
1917	do		498,413	99,682		20.00
1918	do		456,786	91,357		20.00
Calendar year:						
1918	do		383,925	76,785		20.00
1919	do		491,591	98,318		20.00

FROM CUBA (RECIPROCITY TREATY, DEC. 27, 1903).

Fiscal year:						*Per cent.*
1915	20 per cent less 20 per cent		$1,234	$197		16.00
1916	do		1,343	214		16.00
1917	do		266	42		16.00
1918	do		632	101		16.00
Calendar year:						
1918	do		157	25		16.00
1919	do		174	28		16.00

Chemicals, drugs, medicinal and similar substances, in capsules, pills, tablets, lozenges, troches, ampoules, jubes, or similar form, dutiable at not less than 25 per cent. (Act of 1913.)

[Under general tariff.]

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Average ad valorem rate.
Fiscal year:						*Per cent.*
1914	25 per cent		$813,395	$203,348		25.00
1915	do		835,741	208,935		25.00
1916	do		554,102	138,525		25.00
1917	do		515,333	128,833		25.00
1918	do		443,210	110,802		25.00
Calendar year:						
1918	do		356,598	89,149		25.00
1919	do		483,787	120,947		25.00

Chemicals, drugs, medicinal and similar substances, in capsules, pills, tablets, lozenges, troches, ampoules, jubes, or similar form, dutiable at not less than 25 per cent. (Act of 1913)—Continued.

FROM CUBA (RECIPROCITY TREATY, DEC. 27, 1903).

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Average ad valorem rate.
Fiscal year:						*Per cent.*
1914	25 per cent less 20 per cent		$51	$10		20.00
1915	do		20	4		20.00
1916	do		29	5		20.00
1917	do		316	63		20.00
1918	do		32	6		20.00
Calendar year:						
1918	do		32	6		20.00
1919	do		1	0.20		20.00

COURT AND TREASURY DECISIONS.

An article need not be both a chemical compound and a medicinal compound for the purposes of this paragraph. (G. A. 7833, T. D. 36031, of 1915.)

The words "dutiable under this section" refer to articles upon which a duty has been levied, and have no application to articles which would otherwise be exempt from duties; but chemicals, drugs, medicinals, and similar substances, whether dutiable or free, when imported in capsules, pills, ampoules, etc., are dutiable at not less than 25 per cent ad valorem. (G. A. 7623, T. D. 34863, of 1914; Abstract 36915, T. D. 34933, of 1914.)

No mere article of food is comprehended; hence, *infant foods* of the nature of and substitutes for mother's milk, which they closely resemble, containing neither medical nor chemical ingredients, and not used as medicines or chemicals, are not within the provision. (G. A. 8120, T. D. 37466, of 1917.) But articles not strictly and exclusively medicinal, but possessing some therapeutic value, and, because of this quality and of the form in which they appear in the trade, are known and sold to the public as remedial agencies, are within the provision. (7 Ct. Cust. Appls., 118, of 1916.)

As construed by the Treasury Department, all patent medicines, proprietary remedies, chemicals synthetically prepared, and articles combined or compounded with the use of chemicals, come within this provision. Olive oil, oil of lemon, oil of orange, peanut oil, fish oils, and other rendered, expressed, distilled, and essential oils, which are not mixed or compounded with other oils, earths, chalk, crude drugs, which are natural and uncompounded, and similar articles, are excluded, because not similar to chemical and medicinal preparations or combinations. (T. D. 34184, of 1914, modifying T. D. 34035, of 1914.)

In the latest decision of the Court of Customs Appeals (8 Ct. Cust. Appls., 21, of 1917), construing paragraph 17, the following principles were laid down:

1. A compound or combination, in the general understanding, is necessarily something composed of more than one component material, and these expressions in paragraph 17, tariff act of 1913, are not applicable to a natural product.

2. The use of the word "medicinal" in paragraph 17, tariff act of 1913, with reference to compounds or combinations, requires that the compound or combination should have healing or curative properties, and probably that it should be commonly so regarded and used.

3. The expression "all similar articles," used in paragraph 17, tariff act of 1913, with reference to compounds or combinations, applies only to a compound, combination, mixture, or preparation composed of more than one substance or material.

4. The expression "medicinal compounds, combinations, and all similar articles" means, first, strictly medical compounds and combinations, and, second, compounds or combinations similar thereto in that, while not strictly medical because possession properties which adapt them to other uses, are nevertheless susceptible of medicinal uses and, in the form and condition imported, are specially designed therefor and so chiefly used.

The following are among the products held to fall within the provision: *Glycerin* in plain glass bottles less than 2½ pounds gross weight. (G. A. 7833, T. D. 36031, of 1915.) *Isotonique sea water* imported in ampoules for medicinal purposes. (G. A. 7624, T. D. 34864, of 1914.) *Citrate of magnesia* and *preparations of malt* in packages of less than 2½ pounds gross weight. (Abstract 41232, of 1917.) *Extract of taraxacum* or *dandelion extract* and so-called *Elliman's embrocation.* (Abstract 41861, of 1918.) *Calcined magnesia* in packages less than 2½ pounds gross weight. (Abstract 41784, of 1918.) *Antiplague serum* in ampoules. (Abstract 37925, of 1915.) *Radiogen-Trinkwasser* in capsules and ampoules. (Abstract 36915, T. D. 34933, of 1914.)

The following are among the articles held not to come within the provision: *Essence d'Orient,* a solution made from the scales of fish with water and a little ammonia, and used to impart a pearl effect to glass articles such as hatpin tops. (Abstract 40809 and 41175, of 1917.) *Wash blue,* some containing ultramarine, in balls or cubes. (Abstracts 38629 and 38840, of 1915; 39885, of 1916, and 41786, of 1918.) *Writing* and *copying ink.* (Abstracts 37926 and 39005, of 1915.) *Refined camphor* in tablets containing two-thirds of an ounce, packed in tin cans containing 24 tablets. (T. D. 34612, of 1914.) *Naphthalin* and *camphor* in the form of balls and tablets. (T. D. 34199, of 1914.) *Sweet almond* and *castor oil* in bottles of 3 to 4 ounces. (8 Ct. Cust. Appls., 21, of 1917.) *Polishes* for shoes or metal. (Abstracts 39372, of 1916, and 41856 and 41858, of 1918.) *Plastilina,* a modeling clay. (G. A. 7896, T. D. 36361, of 1916.) *Lemon oil* in bottles of less than 2½ pounds gross weight. (Abstract 41855, of 1918.) *Saffron* in packages less than 2½ pounds gross weight. (Abstract 41261, of 1917.) *Enamel paints and colors.* (Abstract 41235, of 1917.) *Adhesive plasters.* (Abstract 40732, of 1917.)

The Board of General Appraisers, declaring the immediate container to be the package contemplated by this paragraph, held a package weighing more than 2½ pounds and containing a large number of small packages each weighing less than 2½ pounds gross to be included. (Abstract 37927, of 1915.) A single package weighing less than 2½ pounds shipped by itself in one container is also included, the Court of Customs Appeals holding the test to be weight regardless of price, quality, origin, method of manufacture, container, suitability for use, or any other matter, and whether in wholesale or retail sales. (9 Ct. Cust. Appls.; T. D. 38208, of 1919.) (See pars. 5 and 16.)

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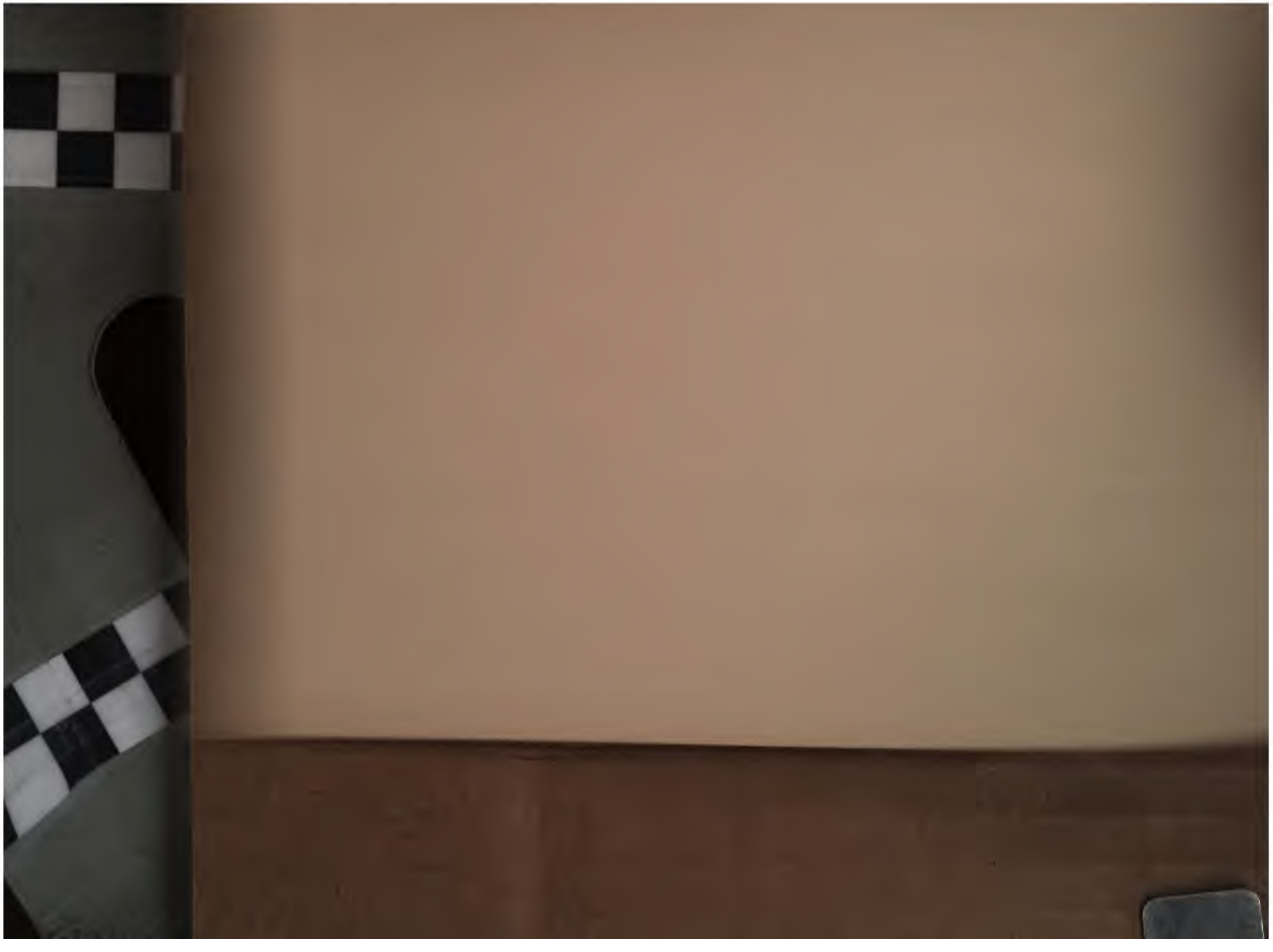

UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 18, 19, 20, 21, 22, 23, 24, 25, and 26 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

MEDICINALS—CHLORINE PRODUCTS—PYROXYLIN PLASTICS

Paragraph 18:
- Chloral Hydrate
- Urea
- Terpin Hydrate
- Glycerophosphoric Acid
- Thymol

Paragraph 19:
- Carbon Tetrachloride
- Chloroform
- Sulphur Chlorides. (Par. 5, n.s.p.f.)

Paragraphs 20–23 inclusive:
- (Repealed by the Act of September 8, 1916)

Paragraph 24:
- Cobalt Oxide

Paragraph 25:
- Collodion
- Pyroxylin Plastics

Paragraph 26:
- Coloring for Liquors

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6-4-29

PREFACE.

This is one of a series of Tariff-Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

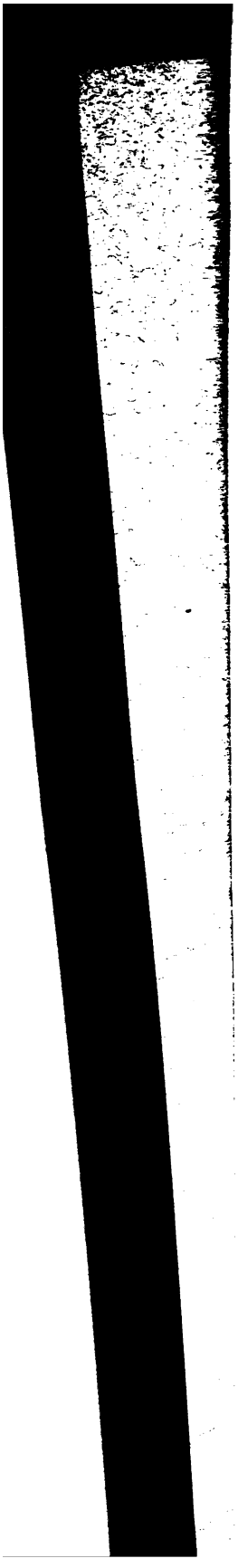
In some cases two or more paragraphs have been combined in one pamphlet. In doing this, industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and Index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus by use of this "Introduction and Index," the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Dr. Grinnell Jones, C. R. DeLong, and A. R. Willis, of the chemical division of the Commission's staff, and of others.



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CHLORAL HYDRATE.

[Par. 18, act of 1913, 25 per cent ad valorem.[

GENERAL INFORMATION.

Description.—Chloral hydrate is a chemical compound having the formula $CCl_3CH(OH)_2$. Its main use is as a drug. It is defined in the United States Pharmacopœia as follows: "A compound of trichloraldehyde or chloral, with the elements of one molecule of water. It contains not less than 99.5 per cent of $CCl_3CH(OH)_2$." It is sometimes erroneously or loosely called chloral. It is a white crystalline solid having a specific gravity of 1.848 and a melting point of 57° C. Chloral hydrate is soluble in water, alcohol, ether, chloroform, turpentine, and light petroleum oils. It has a peculiar odor and a sharp taste. For medicinal purposes chloral hydrate should be free from chloral alcoholate, which has different physiological properties.

Chloral is a chemical compound having the formula CCl_3CHO. It is also called trichloraldehyde. It may readily be converted into chloral hydrate by the simple addition of water. Chloral itself is not used as a drug but is used in the manufacture of chloral hydrate and is combined with other substances to make drugs. Chloral is not specially provided for in the tariff act of 1913 or in any of the preceding acts.

Raw materials.—Chloral hydrate is manufactured from ethyl alcohol and chlorine gas as the raw materials. Certain amounts of sulphuric acid are also used in the usual process of manufacture.

The payment of the internal revenue taxes on the alcohol used as a raw material is avoided in this country by the use of denatured alcohol. The denaturants used are "animal oil or Dipple's oil" and "pyridin bases" derived from crude ammonia liquors of the by-product coke industry. These denaturants are used according to the Bureau of Internal Revenue, Regulations No. 30, formulas 17 and 6b, which require the addition of 0.05 gallon of animal oil or the addition of 0.5 gallon of pyridin bases to 100 gallons of ethyl alcohol.

All of the raw materials necessary in the manufacture of chloral hydrate are produced in this country and the manufacturers in the United States are independent of foreign countries in this respect.

Process of manufacture.—The manufacture of chloral hydrate is divided into three distinct chemical steps: The preparation of chloral alcoholate by the chlorination of ethyl alcohol, the conversion of the alcoholate into chloral by the means of sulphuric acid, and finally the treatment of the chloral with water to form chloral hydrate. The process is carried out as follows:

Denatured alcohol, free from water, is subjected to the action of dry chlorine gas. It is essential that all the materials be as dry as possible. During the chlorination hydrochloric acid is evolved and must be absorbed in water forming a saleable by-product.

The chloral alcoholate while hot is transferred to an enameled still, where it is brought to boiling under a reflux condenser. An equal volume of sulphuric acid is then added to the boiling mixture in small portions, thus converting the alcoholate into chloral. The chloral is distilled from the mixture and the distillate up to 100 degrees is collected and redistilled. The portion distilling over above 94 degrees is collected as pure chloral.

The pure chloral is now mixed with the theoretical amount of water and the resulting chloral hydrate is poured over a smooth surface where it solidifies. To obtain the crystals of chloral hydrate it must be crystallized from chloroform, carbon disulphide, turpentine, or some other similar solvent.

In ordinary practice a yield of 150 pounds of chloral hydrate from 100 pounds of ethyl alcohol is considered to be a good yield. In the manufacture of chloral hydrate there is also produced about 4 pounds of hydrochloric acid (strength of 18 degrees Be.) for every pound of chloral hydrate.

Important uses.—The chief use of chloral hydrate is as a sleep-producing drug; 0.5 gram is the customary dose. It is also used in the extraction of alkaloids, in the analysis of rubber, and in microchemical investigations. Chloral is used to some extent in the manufacture of chloroform for anesthetic purposes. Other minor uses of chloral hydrate or chloral are the preparation of many medicinal mixtures, including the following:

Chloral hydrocyanate, used instead of bitter almonds.

Chloral mentholated, a counterirritant.

Chloral phenolated, for toothache and neuralgia.

Chloral ammonia, for nervous insomnia and neuralgia.

Chloralbacide, to counteract digestive disturbances due to lack of hydrochloric acid.

Chloral benzaldoxime, a hypnotic and antiseptic.

Chloralcaffeine, for nervous insomnia, neuralgia, and headache.

Chloralcamphoroxime, for nervous insomnia, neuralgia, and headache.

Chloralformamide, produces sleep without injurious effects.

Chloralimide, for insomnia and fevers.

History of the industry.—The following description of the chloral hydrate industry was submitted by the Monsanto Chemical Co., St. Louis, Mo.:

The chloral hydrate industry originated and was developed in Germany. The needs of the United States were supplied by German manufacturers up to about 1892, when Herf & Frerichs Chemical Co., of St. Louis, undertook the manufacture of this product from tax-paid alcohol. The manufacture was discontinued several years later owing to the impossibility of competing with the foreign product manufactured from tax-free alcohol. For several years thereafter the United States again depended entirely on Germany for supplies of this product. In 1908 the Monsanto Chemical Works, of St. Louis, undertook to manufacture chloral hydrate, since denatured alcohol had at that time become available in this country for technical purposes.

In 1908 the price of chloral hydrate in this country was 90 cents per pound duty paid (import duty of 55 cents per pound, as a chemical in the preparation of which alcohol was used).

As the above American manufacturer increased his production of chloral hydrate, the price dropped and finally reached about 50 cents per pound in 1913, at which price it was of course impossible to import chloral hydrate under the prevailing duty. Merck & Co. established a plant in this country and started operations in 1912 and, owing to this competition, the price dropped to about 45 cents per pound, which was then considered below the cost price in this country.

After the passage of the Simmons bill, reducing the tariff rate on chloral hydrate to 25 per cent ad valorem, a price fight ensued with European manufacturers who were importing the product at between 20 and 30 cents, so that one of the American plants stopped operations and subsequently dismantled the plant. At the start of the war the price went up to $2.10 per pound, and in 1916 this same plant resumed operations, whereupon the price dropped again to about $1.25 per pound.

Domestic production.—The chloral hydrate industry originated and was developed in Germany. The needs of the United States were supplied by German manufacturers up until about 1892, when a firm in this country undertook its manufacture from tax-paid alcohol. This firm was unable to compete and the manufacture was discontinued. Again this country depended on Germany until in 1908 the Monsanto Chemical Co. undertook to manufacture chloral hydrate since denaturated alcohol was available as a raw material. The price of chloral hydrate in 1908 was 90 cents per pound and declined to 50 cents per pound in 1913. Merck & Co. also began producing chloral hydrate in 1912. After the passage of the act of 1913 which reduced the duty on chloral hydrate to 25 per cent ad valorem the product was imported by European manufacturers at between 20 and 30 cents per pound. One of the American plants ceased operations and dismantled its plant. At the start of the war the price increased to $2.10 per pound and this plant resumed operations, whereupon the price dropped again to about $1.25 per pound.

Foreign production.—Prior to the outbreak of the European War Germany supplied the world's demand for chloral and chloral hydrate.

Imports.—The imports of chloral hydrate are not shown in detail, prior to 1914 although in 1909, 6,096 pounds valued at $1,576 were reported. Imports since 1914 have been practically negligible.

Prices.—The lowest quotation for chloral hydrate was from January to April, 1914 (23–35 cents per pound). This price increased to a maximum of $2–$2.10 per pound in October, 1915. The price then has declined somewhat to about $1.50 per pound in the latter part of 1917. In 1919 there was a gradual decline to 95 cents in October, 1919. During 1920 the price has been between 95 cents and $1 per pound.

Tariff history.—Chloral hydrate was mentioned specifically in the act of 1894 as dutiable at 25 per cent ad valorem. The acts of 1897 and 1909 did not mention it by name. The act of 1913 mentioned it by name again and restored the duty of 25 per cent ad valorem.

Chloral hydrate—Imports for consumption—Revenue.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	55 cents per pound	6,096	$1,756	$3,352	$0.288	191.00
1910		[1]				
1911		[1]				
1912		[1]				
1913		[1]				
1914 [2]	25 per cent	644	241	60	.374	25.00
1915	do	112	25	6	.223	25.00
1916	do	1	2	½	2.00	25.00
1917	do	[3]				
1918	do	1,032	746	187	.72	25.00
1919	do	[4]				
1920	do	[4]				

[1] Probably included in chemicals containing alcohol or in which alcohol is used.
[2] From October to June, 1914.
[3] Listed; none imported.
[4] None.

Chloral hydrate—Prices, wholesale or retail, New York, spot.

[Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.
1912	$0.74–$0.76	$0.74–$0.76	$0.74–$0.76	$0.72–$0.74
1913	.61– .64	.61– .64	.61– .64	.61– .64
1914	.23– .35	.23– .35	.31– .43	.56– .67
1915	.55– .60	.55– .60	.90– 1.00	2.00– 2.10
1916	1.37– 2.10	1.37– 2.10	1.37– 2.10	1.28– 1.45
1917	1.28– 1.45	1.30– 1.40	1.40– 1.45	1.50– 1.55
1918	1.50– 1.55	1.50– 1.55	1.58– 1.63	1.58– 1.63
1919	1.25– 1.33	1.06– 1.08	1.00– 1.01	.95– .98
1920	.95– .98	.95– .98	1.05– 1.13	1.00– 1.15

Chloral hydrate—Rates of duty.[1]

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1894	12	Chloral hydrate	25 per cent ad valorem.
1909	65	Medicinal preparations containing alcohol or in the preparation of which alcohol is used, not specially provided for in this section.	55 cents per pound.
		But in no case shall the same pay less than	25 per cent ad valorem.
		* * *: all other medicinal preparations not specially provided for in this section.	25 per cent ad valorem.
		Provided, That chemical, drugs, medicinal and similar substances, whether dutiable or free, imported in capsules, pills, tablets, lozenges, troches, or similar forms, and intended for medicinal purposes, shall be dutiable at not less than the rate imposed by this section on medicinal preparations.	
1913	18	Chloral hydrate	25 per cent ad valorem.

[1] For laws under the acts of 1883, 1890, and 1897, see Court and Treasury Decisions.

Court and Treasury Decisions.

In the earliest decisions chloral hydrate was classified as a medicinal preparation. (T. D. 698, of 1870, and 1962, of 1874.)

In subsequent litigation there were two questions: (1) Whether chloral hydrate was dutiable as a chemical compound or salt rather than as a medicinal preparation, and (2) whether it was an alcoholic or nonalcoholic medicinal preparation. The one was a question of

relative specificity of the two provisions and the other a question of fact. This litigation was under the acts of 1890 and 1897 (the act of 1894, paragraph 12, provided eo nomine for chloral hydrate at 25 per cent ad valorem). There was a provision in each of these acts (as also in the act of 1883) for chemical compounds and salts. There were two provisions in the act of 1890 for medicinal preparations—(1) paragraph 74, imposing 50 cents per pound upon such preparations "of which alcohol is a component part, or in the preparation of which alcohol is used," n. s. p. f., and (2) paragraph 68, imposing 25 per cent ad valorem on such preparations "not containing alcohol or in the preparation of which alcohol is not used."

The Board of General Appraisers held chloral hydrate dutiable under the provision for "medicinal preparations of which alcohol is a component part or in the preparations of which alcohol is used," and not as a chemical compound or salt. (In re Schering, G. A. 495; T. D. 11052.) The Circuit Court (Eastern District of Missouri) and the Circuit Court of Appeals disagreed with this classification and held chloral hydrate dutiable as a chemical compound because of a doubt whether chloral hydrate was in a strictly legal or dictionary sense a medicinal preparation, since, it was declared, "it can not be administered in the form in which it was imported, but must be further prepared by the druggist or apothecary." (United States *v.* Battle, etc., Corp., 54 Fed. 141, affirming 50 Fed. 402; T. D. 13730.)

Upon new evidence the Board of General Appraisers held chloral hydrate in its condition as imported to be a medicinal preparation of which alcohol is not a component part, but "in the preparation of which alcohol is used." The German manufacturers asserted that this importation was made from alcohol and chlorine gas, and that it was not commercially practicable to manufacture it by any other process. (In re Engelhorn, G. A. 2221; T. D. 14292.) Customs officers were instructed by the Treasury Department to follow this decision. (Dept. Order; T. D. 14352.) The Circuit Court for the Second Circuit, however, following United States *v.* Battle, etc., Corp., supra, held the classification as a chemical compound to be correct. (In re Merck, 66 Fed. 724.) The Treasury Department acquiesced. (Dept. Order; T. D. 14979.) The Board of General Appraisers thereupon held chloral hydrate dutiable as a chemical compound or salt under that act. (In re Roessler, etc., Co., G. A. 2630; T. D. 15077.)

In the tariff act of 1897 (par. 67) a change was made by striking out the words "of which alcohol is a component part" and providing instead for "medicinal preparations containing alcohol, or in the preparation of which alcohol is used" n. s. p. f. The duty was increased to 55 cents per pound with a minimum of 25 per cent ad valorem. The correlative paragraph (68) read: "Medicinal preparations not containing alcohol or in the preparation of which alcohol is not used" n. s. p. f. The duty remained at 25 per cent ad valorem.

In litigation under this act the Board of General Appraisers held chloral hydrate dutiable as a medicinal preparation "in the preparation of which alcohol is used," on the authority of Fink *v.* U. S. (170 U. S. 584), holding that the provision for medicinal preparations was more specific than that for chemical compounds and salts. (In re Phair, G. A. 4412; T. D. 20994.) The Circuit Court for the Southern District of New York reached a different conclusion and

held chloral hydrate dutiable as a medicinal preparation "in the preparation of which alcohol is not used." (Phair *v.* U. S., 105 Fed. 509.) Like decisions were made by circuit courts upon salol and terpin hydrate. These decisions are reviewed in In re Merck, G. A. 4740 (T. D. 22411), in which the Board distinguished Fink *v.* U. S., supra, upon the ground that the subject matter there (muriate of cocaine) was an article in the preparation of which alcohol is necessarily used, whereas it may or may not be used in the manufacture of chloral hydrate.

The Treasury Department did not acquiesce and directed customs officers to classify chloral hydrate as a medicinal preparation "in the preparation of which alcohol is used." (Dept. Order; T. D. 22958.) The Circuit Court for the eastern district of Missouri, following Fink *v.* U. S., supra, sustained the Department's construction. (Battle, etc., Corp., *v.* U. S. 108 Fed. 216.) So did the Circuit Court of Appeals for the second circuit. (United States *v.* Schering, 123 Fed. 65, reversing 119 Fed. 473, and G. A. 4740; T. D. 22411.) The court said that chloral hydrate is a medicinal preparation which contains no alcohol as a component part, but in the preparation of which alcohol is sometimes used, and construed the law to cover all medicinal preparations in the manufacture of which alcohol is used in any way. In the absence of proof it was declared the duty of customs officers to determine the question by resorting to such sources of information as were within their power, the presumption always being that their action is correct. This decision was followed by the board. (In re Bowman, G. A. 5502, T. D. 24823; and In re Schering, G. A. 5567, T. D. 24970.)

The two provisions for alcoholic and nonalcoholic medicinal preparations were combined in paragraph 65 of the act of 1909. The clause for preparations containing alcohol is a reenactment of paragraph 67 of the act of 1897, supra; the other provision was modified to read: "All other medicinal preparations" n. s. p. f., without change in the rate of duty.

Customs officers were instructed by the Treasury Department to classify chloral hydrate as an alcoholic medicinal preparation under that act even if the invoices were accompanied with certificates to the effect that ethyl alcohol was not used in the preparation, in the conviction that "ethyl alcohol is uniformly employed in the production of the technical chloral hydrate or anhydrid, which is used in the manufacture of the pure chloral hydrate." (Dept. Order, T. D. 32738.)

UREA.

[Par. 18, act of 1913, 25 per cent ad valorem.]

General Information.

Description.—The substance NH_2 $CONH_2$ known as urea, exists in the urine of mammals as well as in the blood, milk, and other animal fluids. When pure this substance crystallizes in transparent, colorless, four-sided prisms. It is odorless and possesses a cool saline taste like that of niter. Urea melts when heated to 132° C. It has the property of forming both inorganic and organic salts which are of technical and medicinal importance. Urea has the property of combining with and destroying the oxides of nitrogen and it is due to this action that urea finds such extensive use in the manufacture of celluloid and other pryoxylin plastics.

Uses.—Possibly the greatest commercial use of urea and its salts to-day is as a stabilizer in pyroxylin plastics. Other stabilizers can be used for this purpose, but they have certain disadvantages. The proportion of urea required for this purpose is quite small (½ to 2 parts of urea to 100 parts of pyroxylin plastic) but in the aggregate amounts to a considerable quantity. Mr. Frank P. Washburn, president of the American Cyanamid Co., stated in an article in 1915, * * * "the United States imports about $50,000 worth of a high-grade urea annually for the manufacture of celluloid" * * *. Its use as an antacid has been known at least as early as 1855, when it was used in a small quantity for correcting the acidity of photographic films.

It was formerly used as a stabilizer of American military powders, but due to the fact that it is a direct, although a feeble nitrocellulose solvent, it has been displaced in this use by diphenylamin.

Urea and its salts, such as the nitrate, oxalate, acetate, citrate, and hydrochloride, are used in medicine for the treatment of such diseases as hepatic cirrhosis, simple serous pleuresy, renal calculus, etc.

In 1894, R. C. Schupphaus described the value and application of urea in connection with the stability of nitro compounds. For this use he advocated the use of one-half to 2 per cent of urea dissolved in wood alcohol or a similar solvent. In this condition it was to be added to the mass along with camphor just before the conversion took place. He further claimed that any nitrous or nitric acid subsequently generated in the plastic and coming in contact with urea would react, yielding carbon dioxide, nitrogen, and water. By using urea for this purpose the objectionable features of the use of sodium silicate were overcome.

C. Classen found that the decomposition of substituted ureas in which all the hydrogen atoms are replaced by organic radicals decompose more readily in the presence of traces of inorganic acids

than urea itself. From this action the inference is drawn that antacids and the substituted ureas would be more efficient in that they would react with smaller quantities of inorganic acids.

Many antacids proposed are antagonistic to pyroxylin, whereas urea and some of its esters and substitution products are direct although feeble nitrocellulose solvents.

The compounds of urea that have been claimed as preserving agents include the benzoate, salicylate and naphthoate, dissolved in a compatible menstrum as alcohol; the formate, acetate, propionate, butyrate and valerate. The average amount used is about 1 per cent of the weight of the pyroxylin.

Substitutes.—John H. Stevens has made an elaborate study on the subject of stability of pyroxylin plastics in which he used a new class of preserving agents of distinct efficiency and which may be considered as possible substitutes for urea and its salts. The substances used included sodium, potassium, calcium, strontium, and magnesium lactates, inorganic salts of chlorformates, chloracetates, chlorpropionates, and chlorbutyrates; the acetates, propionates, butyrates and valerates, of lithium, calcium, zinc, manganese, lead, potassium, and sodium; the chlorformate and chloracetate of zinc. Sodium benzoate, salicylate, camphorate, and hypophosphite together with barium butyrate, are all claimed to possess distinct value for certain restricted uses. *Lactamide* (amide of lactic acid) is used as a substitute on account of its easy solubility in alcohol and its freedom from discoloration properties in light as distinguished from anilin, diphenylamin and similar amido and imido bodies.

Method of manufacture.—Urea may be prepared by several methods, but the most important process used in the United States at present is that of treating calcium cyanamid with a mineral acid. It may also easily be prepared by treating dicyandiamid with hot water; by the action of ammonia gas on phosgene; and by boiling an aqueous solution of ammonium cyanate. In Germany urea was obtained as a by-product in the manufacture of cyanides. In the manufacture of cyanides some cyanate is unavoidably obtained and this is readily converted into urea by boiling with water.

Domestic production.—Urea has been manufactured in the United States only since the latter part of 1916. Prior to that time the entire supply came from foreign countries.

The method of manufacture in this country is that of treating calcium cyanamid with water in the presence of a mineral acid, such as sulphuric. It may also be easily prepared by the action of phosgene gas upon ammonia.

The raw material used in this country in the manufacture of urea-calcium cyanamid is manufactured by an American firm in Canada. The manufacture of this product depends upon a cheap source of electric power. This product is then imported into this country in large quantities for use in commercial fertilizers (see Tariff Information Survey—Calcium Cyanamid) and in the manufacture of urea.

The manufacture of urea was undertaken in this country at Warners, N. J., on account of the curtailment of supplies from Germany.

The annual production of this commodity is not known, but based upon a statement of the president of the American Cyanamid Co. would probably not exceed 200,000 pounds per year.

Foreign production.—In Germany it has been reported that urea was manufactured as a by-product from the cyanide industry. In the manufacture of cyanides, a small quantity of cyanate is obtained, from which urea is made by treatment with boiling water.

Imports.—Before the war Germany was the principal contributing country for this commodity, exporting large supplies to the United States for use in the manufacture of pyroxylin plastics.

The imports of urea were not shown prior to 1914 but were included in the imports for all other medicinal preparations in which alcohol is used not specifically enumerated.

The imports for consumption of urea in 1915 and 1916 show a marked increase over the reported importation for 1914 but this may be partly explained by the fact that the act of 1914 was not passed until October 3, and until that time urea was not specifically enumerated. The imports for 1917 and 1918 show a decrease which is probably due to the influence of the American-made product.

Prices.—The prices for urea are not shown in market quotations, but from a reliable source it was learned that prior to the war urea was selling at 30 cents per pound, while at present (1918) the price is about $2 per pound.

Tariff history.—Urea was not specifically mentioned in the tariff acts prior to the act of 1913. In this act it is dutiable at 25 per cent ad valorem.

Urea—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.
Fiscal years:		*Pounds.*			
1914	25 per cent	17,981	$8,798	$2,199	$0.489
1915	do	65,464	31,994	7,998	.488
1916	do	79,192	32,498	8,125	.410
1917	do	56,429	36,248	9,062	.642
1918	do	22,677	17,479	4,369	.770
1919	do	11,576	7,693	1,923	.664
Calendar years:					
1918	do	9,929	8,149	2,037	.820
1919	do	14,290	9,741	2,435	.681
1920[1]	do	15,979	8,736	2,184	.546

[1] Six months ending June 30, 1920.

Urea—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	18	Urea For laws from 1883 to 1909, see Chloral Hydrate, supra.	25 per cent ad valorem.

Court and Treasury Decisions.

Urea was held dutiable under the specific provision therefor in the act of 1913 and not as a chemical compound. (Abstract 39434.)

The Treasury Department instructed customs officers to classify urea as a chemical salt in the preparation of which alcohol is used, under the act of 1909. (Dept. Order, T. D. 30696.)

[For classification under prior acts see Chloral Hydrate, supra.]

TERPIN HYDRATE.

[Par. 18, act of 1913, 25 per cent ad valorem.]

General Information.

Description and uses.—Terpin hydrate is the chemical name given to the substance $C_6H_8(OH)_2(CH_3)$ (C_3H_7) $\cdot H_2O$. The compounds crystallize in colorless, lustrous rhombic prisms, which have a slight aromatic odor and bitter taste. Terpin hydrate is used chiefly as a medicinal in the treatment of disease.

Manufacture.—Terpin hydrate is manufactured commercially by the action of nitric acid and alcohol upon turpentine oil.

This medicinal is being manufactured in the United States by three firm in New York City, two firms in the State of Pennsylvania, one company in New Jersey, and one in St. Louis. The production statistics, however, are not available from official sources.

Imports.—The imports for this commodity in 1915 were 4,477 pounds as compared with 6,929 pounds imported in 1914 or a decrease of over 35 per cent. No imports have been reported since 1915.

Prices.—The wholesale price of terpin hydrate has ranged between 48 cents to $1.20 per pound from July, 1916, to October, 1920.

Tariff history.—Terpin hydrate was not specifically mentioned in the tariff acts until the act of 1913. In this act it appears in paragraph 18, at 25 per cent ad valorem.

The Treasury Department instructed customs officers to classify terpin hydrate as a chemical salt in the preparation of which alcohol is used, under the act of 1909. (Dept. Order, T. D. 30696.) Under this decision terpin hydrate would be covered by paragraph 3 of this act and assessed at 55 cents per pound. In previous acts this commodity would be assessed at 25 per cent ad valorem, under the paragraphs "chemical compounds and salts, n. s. p. f."

Terpin hydrate—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914[1]	25 per cent	6,929	$1,020	$255	$0.147	25.00
1915	do	4,477	657	164	.146	25.00
1916	do					
1917	do					
1918	do					
1919	do					
1920	do					

[1] Not separately shown prior to 1914.

Terpin hydrate—Prices, wholesale, New York spot.

[From Oil, Paint, and Drug Reporter.]

July, 1916	$0.50–$0.55	January, 1919	$0.48–$0.50
October, 1916	.50– .55	April, 1919	.48– .50
January, 1917	.55– .60	July, 1919	.65– .66
October, 1917	.55– .60	October, 1919	.65– .66
January, 1918	.55– .60	January, 1920	.92– .95
April, 1918	.55– .60	April, 1920	1.13– 1.15
July, 1918	.48– .50	July, 1920	1.15– 1.20
October, 1918	.48– .50	October, 1920	1.05– 1.08

Terpin hydrate—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	18	Terpin hydrate For laws under the acts of 1883, 1894, see Chloral hydrate, supra.	25 per cent ad valorem.

Court and Treasury Decisions.

Terpin hydrate was classified under the act of 1890 as a medicinal preparation of which alcohol is not a component part. Engelhorn *v.* U. S., suit 1237, unreported. Acquiesced in by the Treasury Department, T. D. 22002; followed under the act of 1897 in G. A. 5048 (T. D. 23423).

The Treasury Department later instructed customs officers to classify terpin hydrate as a chemical salt in the preparation of which alcohol is used under the act of 1909. (Department order, T. D. 30696.)

[See also Chloral Hydrate, supra.]

GLYCEROPHOSPHORIC ACID AND SALTS AND COMPOUNDS.

[Par. 18, act of 1913, 25 per cent ad valorem.]

General Information.

Description.—When glycerol and phosphoric acid are heated together, a number of compounds are obtained. The most important compound commercially is the mono-glyceride of ortho-phosphoric acid—called glycerophosphoric acid. When this compound is freshly prepared, it is a clear colorless liquid, but upon standing it slowly decomposes into glycerine and phosphoric acid. This change is accompanied by a change in the color of the liquid from water white to yellow. Glycerophosphoric acid is capable of forming both normal and acid salts. The acid itself is not used in pharmaceutical practice. Its salts are, however, used in medicine, especially the sodium and potassium compounds. The acid itself is not known to have any technical use other than in the preparation of the salts. These compounds are not used to any great extent in pharmaceutical practice in this country. They are used to some extent in medicine in France. The acid possesses a sweet acrid taste and is rarely obtained pure. Upon evaporation, it decomposes into its components.

Official salts in U. S. P.—The official *calcium glycerophosphate* is the normal salt called glycerophosphate of lime. (Calcium phosphoglycerate, glycerophosphate de chaux.) It must contain when dried to constant weight at 130° C. not less than 98 per cent of $CaC_3H_7PO_6$. It occurs as a fine white powder, odorless and almost tasteless. It is somewhat hygroscopic.

It is used where lime and phosphorus are required as in rachitis, neurasthenia, scrofula, difficult dentition, incontinence of urine, wasting disease and convalescence. The phosphorus of lecithin in food is converted into glycerophosphoric acid before assimiliation; hence it is the most natural form for administering phosphorus.

Sodium glycerophosphate, which formerly existed as a pasty mass, can now be found in commerce in solid plates or scales. This renders this compound more convenient for pharmaceutical use. The official sodium glycerophosphate is the normal salt. It is described as white monoclinic plates or scales, or as a white powder having a saline taste and odorless. It is very soluble in water. Its use in medicine as a stimulant for the central nervous system is not fully acknowledged by all authorities. It is used for deficient nerve nutrition, neurasthenia, Addison's disease, phosphaturia, convalescence from influenza, lumbago, etc.

Potassium glycerophosphate is a colorless to yellowish liquid. It is used for the same purposes as the sodium glycerophosphate.

Ferric glycerophosphate (ferrum glycermophosphonium, iron glycerophosphate, glycerin phosphorsauers Eisens) is in yellowish green transparent amorphous scales or powder. It is odorless and nearly tasteless. This compound is prepared by dissolving freshly made ferric hydroxide in glycerophosphoric acid. It is used in deficient nerve nutrition, neurasthenia, anemia, chlorosis, Addison's disease, phosphaturia, convalescence from influenza, beriberi, etc.

Manganese gylcerophosphate (manganic glycerophosphas solubilis, soluble manganous glycerinophosphate).—This compound is a yellowish or pinkish white powder, odorless and with an acid taste. It is insoluble but is made soluble by the addition of citric acid. It is used in medicine for the same purposes as the iron compound.

Quinine glycerophosphate exists in both the basic and the neutral condition. The basic salt, which is stable, may be made by dissolving quinine in ether and mixing with glycerophosphoric acid. It is a white powder, soluble in water, and contains 68 per cent quinine.

Strychnine glycerophosphate occurs in white rhombic crystals or as a white powder, odorless and having a faint sweetish taste which becomes intensely bitter. It has no advantages medicinally over other strychnine salts. It is used for the same purposes as the alkaloid.

Domestic production.—Glycerophosphoric acid is prepared from the action of phosphoric anhydride or glacial phosphoric acid on glycerol. It is also prepared by boiling lecithin with barium or sodium hydroxide.

Glycerol (par. 35) and phosphoric acid (par. 387) are manufactured in the United States in large quantities and therefore obtainable for use as raw materials in the manufacture of this commodity. Lecithin is a complex chemical compound obtained from the yolks of eggs. The domestic production of this substance is not known.

The manufacture of glycerophosphoric acid and the glycerophosphates is confined to firms engaged in the manufacture of a general line of pharmaceuticals, as the demand for these materials is not great enough to make them the sole products.

It is reported that there are two firms manufacturing these commodities in New York State, two in St. Louis, Mo., and one in Philadelphia.

Imports.—The imports for these commodities show a decrease since 1914, with an increase in the value. In 1917, 5,853 pounds of the acid and salts of were imported as compared with 24,789 pounds in 1914, 15,933 in 1915, and 7,668 pounds in 1916. The value per unit in 1914 was 93 cents while in 1917 this value had increased to $1.58 per pound.

Tariff history.—Glycerophosphoric acid and salts and compounds thereof were not specifically mentioned in the tariff acts previous to the act of 1913. In this act it appears in paragraph 18 at 25 per cent ad valorem. In the paragraphs of the previous acts in which these commodities would be assessed the rate is 25 per cent ad valorem.

G. A. 7895 (T. D. 36360) and G. A. 8989 (T. D. 36819) held that quinine glycerophosphate was not dutiable as glycerophosphoric acid under the act of 1913.

The latter decision was affirmed by the Court of Customs Appeals in United States *v.* Merck (8 Ct. Cust. Appls., 137).

Glycerophosphoric acid and salts and compounds thereof—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914	25 per cent	24,789	$23,066	$5,767	$0.930	25.00
1915	do	15,933	17,678	4,419	1.109	25.00
1916	do	7,668	8,242	2,060	1.070	25.00
1917	do	5,853	9,249	2,312	1.580	25.00
1918	do	961	1,884	471	1.960	25.00
1919	do	2,630	6,967	1,742	2.649	25.00
Calendar years:						
1918	do	209	849	212	4.062	25.00
1919	do	3,840	10,274	2,568	2.675	25.00
1920 [1]	do	5,823	8,886	2,221	1.526	25.00

[1] Six months ending June 30, 1920.

Glycerophosphates, calcium—Prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

July 3, 1916	$1.70–$1.75	Jan. 6, 1919	$1.80–$1.90
Oct. 2, 1916	1.70– 1.75	April, 1919	1.85– 1.95
Jan. 1, 1917	1.70– 1.75	July, 1919	1.70– 1.80
Oct. 1, 1917	1.70– 1.75	October, 1919	1.70– 1.80
Dec. 31, 1917	1.70– 1.75	January, 1920	1.70– 1.80
Apr. 1, 1918	1.85– 1.90	April, 1920	1.70– 1.80
July 1, 1918	1.75– 1.80	July, 1920	1.75– 1.85
Sept. 30, 1918	1.80– 1.90	October, 1920	1.75– 1.85

Glycerphosphates, soda, crystals—Prices, per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

July 3, 1916	$2.55–$2.60	Jan. 6, 1919	$2.20–$2.30
Oct. 2, 1916	2.55– 2.60	April, 1919	2.50– 2.60
Jan. 1, 1917	2.55– 2.60	July, 1919	2.25– 2.35
Oct. 1, 1917	2.55– 2.60	October, 1919	2.25– 2.35
Dec. 31, 1917	2.55– 2.60	January, 1920	2.25– 2.35
Apr. 1, 1918	2.25– 2.30	April, 1920	2.25– 2.35
July 1, 1918	2.15– 2.20	July, 1920	2.25– 2.35
Sept. 30, 1918	2.20– 2.30	October, 1920	2.25– 2.35

Glycerophosphates, soda, liquor (75 per cent)—Prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

July 3, 1916	$1.35–$1.40	Jan. 1, 1919	$1.20–$1.30
Oct. 2, 1916	1.35– 1.40	April, 1919	1.20– 1.30
Jan. 1, 1917	1.35– 1.40	July, 1919	1.15– 1.25
Oct. 1, 1917	1.35– 1.40	October, 1919	1.15– 1.25
Dec. 31, 1917	1.35– 1.40	January, 1920	1.15– 1.25
Apr. 1, 1918	2.05– 2.10	April, 1920	1.15– 1.25
July 1, 1918	1.25– 1.30	July, 1920	1.75– 2.25
Oct. 1, 1918	1.20– 1.30	October, 1920	1.75– 2.25

Glycerophosphoric acid and salts and compounds thereof—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	18	Glycerophosphoric acid and salts and compounds thereof. [For the laws under the acts of 1883 to 1909 see Chloral hydrate, supra.]	25 per cent ad valorem.

GUAIACOL CARBONATE.

(Par. 18, act of 1913, 25 per cent ad valorem.)

GENERAL INFORMATION.

Description.—Guaiacol is the monomethyl ether ($C_7H_8O_2$ or $C_6H_4(OH)(OCH_3)$) of ortho-dihydroxybenzene (pyrocatechin) obtained from wood-tar creosote or prepared synthetically. Creosote and its compounds and phenol are closely allied in action.

Synonyms.—Ortho-dioxybenzene-methyl ester; methyl-orthodioxy benzene; methyl-pyrocatechin; catechol-monomethyl-ether.

Preparation.—Guaiacol may be obtained by fractional distillation of beechwood-tar creosote. The fraction passing over between 200° and 205° C. is treated with ammonia and fractionated again. The lower boiling fraction is dissolved in ether and treated with an alcoholic solution of potassium hydroxid. Potassium-guaiacol separates out. This is washed with ether and crystallized from alcohol, and the guaiacol obtained by treatment with dilute sulphuric acid.

Several processes have been proposed for the synthesis of guaiacol. It may be formed, together with potassium sulphate and water, by heating a molecular mixture of pyrocatechin, potassium hydroxide, and potassium methylsulphate. Guaiacol is removed by solution in alcohol or petroleum-ether and purified by recrystallization. By another method sodium, pyrocatechin, and methyl iodide are heated in methyl alcohol, treated with sodium hydroxide solution and filtered. Guaiacol is liberated from the resulting combination by treatment with hydrochloric acid, distilled, and crystallized.

Compounds and derivatives.—These form a rather numerous class, over 20 being briefly described in the U. S. Standard Dispensatory (1916) to which reference may be made for their names, synonymy and uses. A large number are more extensively discussed in a series of articles by F. G. Ehlert in the Pharmaceutical Review, 1901–2. In general these products are of German origin, of a proprietary type, and have been introduced in the endeavor to present the valuable properties of guaiacol in a tasteless or less irritant form, or to combine the virtues of guaiacol with those of some other medicinal agent. In general their uses are those of guaiacol. Of these numerous substances, guaiacol carbonate only has received official recognition; also, it is the only guaiacol product specifically mentioned in the act of 1913.

Guaiacol carbonate may be formed by passing phosgene gas (carbonyl chloride) into guaiacol dissolved in caustic soda solution. Guaiacol carbonate separates out and sodium chloride remains in solution. The carbonate is washed with caustic soda solution, and crystallized from alcohol. It was introduced under the name of Duotal by a German firm; the United States patent has expired.

Benzosol, or guaiacol benzoate; guaiamar, or guaiacolglycerylester; monotol, or guaiacol methylglycolate; styracol, or guaiacol cinnamate; guaiacol-salol or salicylate of guaiacol are noted in New and Non-Official Remedies, 1917. All but guaiamar are of German origin; the United States patents on benzosol and guaiamar have expired; that on monotol expires in 1923. The name "styracol"

is protected by trade-mark, but the substance appears not to be patented.

Uses.—The uses of guaiacol are similar to those of creosote, its parent substance. It is used in the treatment of pulmonary tuberculosis; it diminishes the cough, but has no specific action on the tubercle bacillus. It has also been used as an antipyretic in fevers, but is apt to produce collapse. It is locally employed in ointments in skin diseases for its anesthetic and antiseptic effects. Guaiacol, and more particularly guaiacol carbonate, are used as intestinal antiseptics. The only official preparation of guaiacol is the petroxylin.

Guaiacol carbonate—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1914	25 per cent	1,637	$2,645	$661	$1.62	25
1915	do	6,907	11,125	2,781	1.61	25
1916	do	469	1,160	290	2.47	25
1917	do	200	6,458	1,614	32.29	25
1918	do	9,517	75,671	18,917	7.95	25
Calendar years:						
1918	do	10,196	79,968	19,992	7.84	25
1919	do	1,915	19,281	4,820	10.06	25
1920 [1]	do	1,531	8,763	2,191	5.65	25

[1] Six months ending June 30, 1920.

Guaiacol, liquid—Prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$1.70–$1.80	July, 1915	$2.30
Apr. 1, 1912	1.70– 1.80	October, 1915	2.50
July 1, 1912	1.70– 1.80	January, 1916	13.75
Sept. 30, 1912	1.70– 1.80	April, 1916	13.75
Dec. 30, 1912	1.70– 1.80	July, 1916	13.75
Mar. 29, 1913	1.70– 1.80	October, 1916	$15.00–16.00
June 30, 1913	1.70– 1.80	January, 1917	15.00–16.00
Sept. 29, 1913	1.70– 1.80	April, 1917	15.00–16.00
Dec. 29, 1913	1.70– 1.80	July, 1917	15.00–16.00
Mar. 30, 1914	1.70– 1.80	October, 1917	15.00–16.00
June 29, 1914	1.70– 1.80	Dec. 31, 1917	15.00–16.00
August, 1914	1.70– 1.80	January, 1920	7.40– 7.50
Oct. 1, 1914	2.30	April, 1920	6.75– 7.50
January, 1915	2.30	July, 1920	6.75– 7.50
April, 1915	2.30	October, 1920	6.00– 6.25

Guaiacol carbonate—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	18	Guaiacol carbonate	25 per cent ad valorem.

(For laws from 1883 to 1909, see Chloral hydrate, *supra.*)

Court and Treasury Decisions.

Guaiacol carbonate was held dutiable as a nonalcoholic and not as an alcoholic medicinal preparation under the act of 1909, on the authority of United States *v.* Hoffman-La Roche Chemical Works (1 Ct. Cust. Appls., 276), which, however, turned upon a jurisdictional question. In re Amermann, T. D. 31524. And under the act of 1897 (United States *v.* Lehn, 2 Ct. Cust. Appls., 59, of 1911).

(For classification under prior acts see Chloral hydrate, *supra.*)

THYMOL.

[Par. 18, dutiable at 25 per cent advalorem.]

General Information.

Thymol belongs to that class of chemical compounds known as phenols and occurs in the volatile oil of *Thymus vulgaris* Linne (Fam. *Labiatae*) and in some other volatile oils.

Substitutes.—Phenol may be employed as an internal or external antiseptic, but is irritating and of higher toxicity. A number of proprietary disinfectants are used for similar purposes. As a substitute for thymol in hookworm disease, oil of chenopodium has lately attracted favorable attention, as has chloroform in veterinary practice.

Carvacrol, a substance closely allied to thymol, occurring in the oils of *Monarda fistulosei L.*, *Origanum dubium Boiss* (Cypress origanum), *O. onites L.*, (Smyrna origanum), *Satureia hortensis L.* and *S. montana L.*, (white thyme) has recently been suggested in England as substitute for thymol in antiseptic use. The oil of cypress origanum is a commercial commodity, 4,200 pounds, valued at £980, being exported to the United Kingdom in 1913. 82.5 per cent of this oil is carvacrol, and preparations of origanum oil under the name of "Perfumed Formosyls" have been prepared for medical use in Great Britain.

Uses.—Thymol is official in the principal pharmacopœias. It was introduced into medicine as a substitute for phenol, and in action stands midway between this and oil of turpentine. As an antiseptic it is more powerful and permanent than phenol, and much less poisonous, but its insolubility in water, its high price, and its odor, which is extremely attractive to flies, prevent its general use for this purpose. Thymol is employed as a gargle or spray in throat affections and as an ointment in skin disease. Its chief internal application is in hookworm disease; it is almost a specific against the parasite. It has been employed as an intestinal antiseptic in typhoid and other bacterial disease of the intestines.

It is frequently used as an antiseptic ingredient of dentifrices.

Official salt.—Thymol iodide (Aristol, dithymol diiodide) is obtained by the addition of an iodine–potassium iodide solution to thymol in a solution of sodium hydroxide. It possesses in part the antiseptic properties of both thymol and iodine, and is used as a substitute for iodoform, being less efficient in most connections, and is used when the odor of iodoform would be objectionable.

Unofficial salts.—Thymol carbonate, or thymotal, is an efficient vermicide, and useful in hookworm disease.

Thymol salicylate of salithymol, thymacetin, and thymoform are less important derivatives.

Production.—Thymol is a constituent of the essential oils of several plants, the most worthy of note being *Thymus vulgaris L.*, *Monarda punctata L.* (fam. Labiatae) and *Carum copticum Benth & Hook. f.* (fam. Umbelliferae). Commercial supplies of thymol have come almost wholly from the latter plant. Thymol from *Thymus vulgaris* (Thyme) has recently been offered in England, but the product is said not to fulfill pharmacopoeial requirements, the reason given being that, under present excise requirements, thymol can not be crystallized in England from pure alcohol. Production of thymol from *Monarda punctata L.* (Horsemint) is still in the experimental stage, and will be further noted under "Competitive Conditions."

The seed of *Carum copticum* (also known as *Carum ajowan*, *Ptycholis coptica*, P. *ajowan*), known commonly as ajowan, is derived from a herbaceous plant closely related to caraway, cultivated throughout India, especially in Bengal, and growing also in Egypt, Persia, and Afghanistan. It has been introduced into Europe, but commercial supplies have come wholly from India. Oil exists in all parts of the plant, but only that of the seed contains thymol in commercial quantities (45–55 per cent as against 1 per cent in the oil of the plant aside from the seed). The oil is obtained by steam distillation and distilled to drive off the more volatile constituents (Cymene, etc.). The residue (above 200° C.) is treated with sodium hydroxide solution, which takes up the thymol, which is precipitated as an oily layer by the addition of hydrochloric acid. Thymol crystallizes out on cooling, and may be purified by clarifying and recrystallization from alcohol. It may also be obtained by fractional distillation and crystallization, or by refrigeration of ajowan oil. The details of the German commercial processes are trade secrets. Before the war German firms had practically no outside competition, and recent efforts by English chemists to produce an equally valuable product do not appear to have been wholly successful.

Thymol has been produced to some extent from ajowan seed in the United States, although in normal times supplies have usually been imported. In recent years several American plants have been found to yield a considerable amount of thymol and production has been experimentally undertaken by the United States Department of Agriculture, by several experimental stations, and commercial firms. The present commercial status has not been investigated.

Previous to the war Germany had a virtual monopoly of the manufacture of thymol, which was produced by more or less secret processes from ajowan seed imported from India. The product was also manufactured by synthesis. In other European countries efforts have been made with some success to prepare thymol from other plants. A factory has also been established by the British Government in India. Its product has apparently been absorbed by British governmental agencies.

Synthesis of thymol.—Several methods have been proposed for the synthesis of thymol. The chief organic compounds from which it may be derived are cumidine, paracymol, menthone, buchu camphor (diosphenol) dimethyloxystyrol, and metacreasotic acid methyl ester. In general it may be said that these compounds are fully as expensive as thymol under normal conditions, and the processes by which thymol is derived from them are also expensive as well as complicated. While it has sometimes been hinted that synthetic processes were in use

in German factories, the large German imports of ajowan seed and the normal price of thymol leave room for doubt as to whether such processes are of commercial importance.

A synopsis of synthetic processes and references to original literature may be found in Abderhalden (see Bibliography).

Thymol was first used in India; a crude product has been prepared there to some extent for oriental consumption, but scarcely for European and American commerce.

The oil of thyme contains 20–30 per cent and that of horsemint as much as 60 per cent thymol.

The price of ajowan seed, and therefore of thymol, normally depends on sanitary conditions in India, being highest during epidemics of plague, cholera, etc.

Imports.—Imports prior to 1914 are not listed. For the years 1914–1918 an average annual amount of 12,199 pounds, valued at $33,136, is reported. During this period the commodity has yielded an annual average revenue of $8,334. A large increase in imports is noted in 1918.

Prices.—Import values per pound for 1914–1918 range between $1.30 and $7.81. American wholesale prices for 1912–1918 vary between $1.40 and $18 per pound.

War disturbances.—The production of thymol before the war was, as has been noted, in effect, a German monopoly. With the severance of the German supply thymol went practically out of the market. Thymol shortage was felt particularly in England, and efforts at production were made without apparently conspicuous success. A factory subsidized by the British Government is said to have been established in India, but its product apparently is wholly devoted to the needs of the British Government in India and elsewhere. The substitutes elsewhere noted have been largely developed under the stimulus of war necessities. Various pine oils are now largely used as disinfectants, and these also may be considered thymol substitutes or rivals in certain connections.

Competitive conditions.—No attempt to grow the ajowan plant in America has been noted. The horsemint (*Monarda punctata*), which occurs as a common weed in the sandy lands of central Florida, yields 0.12 to 0.20 per cent of a volatile oil whose thymol content ranges from 56 to 62 per cent. Hood reviews investigations made by the Bureau of Plant Industry, United States Department of Agriculture, as to the commercial possibilities of this plant. Promising results were obtained in cultivation of the plant and production of thymol on a small scale. Seed was gathered from wild plants; selection of types promised well in developing a strain of horsemint above the average in thymol content. The plant grew well (in Florida) and its cultivation was inexpensive. A plantation should last five years. Estimating the selling price of thymol at $2 per pound the writer shows an annual profit of about $16 per acre per year in the five-year period. He believes that the production of horsemint for thymol might be profitable in connection with other oil-yielding plants for which a distilling apparatus is required.

The production of thyme for thymol would probably not be commercially feasible in America.

Exports of ajowan seed from India (fiscal years).

Exported to—	1909–10		1910–11		1911–12	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Straits Settlements	79,296	1,937	27,552	880	33,376	1,358
Germany	4,370,464	87,159	1,383,536	17,505	1,591,520	18,439
United States of America	739,200	14,726	.....	.....	44,800	521
All other	36,288	847	22,064	565	67,984	1,985
Total	5,225,248	104,669	1,433,152	18,950	1,737,680	22,303

Exported to—	1912–13		1913–14		1914–15	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Straits Settlements	44,800	1,411	20,608	555	17,024	506
Germany	2,134,160	24,989	782,880	10,205	682,640	10,181
United States of America	179,200	2,078	268,800	3,115	67,200	779
All other	66,640	1,378	23,520	642	58,352	1,849
Total	2,424,800	29,856	1,095,808	14,517	825,216	13,315

Exported to—	1915–16		1916–17		1917–18	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Straits Settlements	30,688	852	20,496	779	45,920	1,518
Germany	.....	.....	.....	.....	.....	.....
United States of America	1,011,584	14,410	896,336	13,310	312,144	8,438
All other	420,672	8,443	325,584	6,857	88,816	3,498
Total	1,462,944	23,705	1,242,416	20,946	446,880	13,454

Source: East India (Trade)—Tables relating to the trade of British India with the British Empire and Foreign Countries.

Thymol—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		Pounds.				Per cent.
1914	25 per cent	19,045	$24,765	$6,191	$1.30	25.00
1915	do	4,772	12,921	3,230	2.70	25.00
1916	do	443	1,973	493	4.45	25.00
1917	do	1,759	13,741	3,435	7.81	25.00
1918	do	34,978	113,279	28,319	3.23	25.00
1919	do	8,430	75,013	18,753	8.90	25.00
Calendar years:						
1918	do	33,743	105,829	26,457	3.13	25.00
1919	do	10,747	82,470	20,618	7.67	25.00
1920 [1]	do	4,429	29,035	7,259	6.55	25.00

[1] Six months ending June 30, 1920.

Thymol—Prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

Jan. 1, 1912	$1.25–$1.30	Oct. 2, 1916	$9.50–$10.00
Apr. 1, 1912	1.25– 1.30	Jan. 1, 1917	10.50– 11.50
July 1, 1912	1.35– 1.50	Apr. 2, 1917	16.00– 17.00
Sept. 30, 1912	1.75– 1.80	July 2, 1917	17.50– 18.00
Dec. 30, 1912	1.85– 1.90	Oct. 1, 1917	17.00– 17.50
Mar. 31, 1913	1.85– 1.90	Dec. 31, 1917	17.00– 18.00
June 30, 1913	1.85– 1.90	January, 1918	17.00– 18.00
Sept. 29, 1913	1.65– 1.70	April, 1918	16.00– 18.00
Dec. 29, 1913	2.25– 2.50	July, 1918	13.75– 14.00
Mar. 30, 1914	2.25– 2.50	October, 1918	13.00– 13.50
June 29, 1914	2.20– 2.35	January, 1919	13.50– 13.75
Sept. 28, 1914	9.00– 12.00	April, 1919	10.00– 10.50
Dec. 28, 1914	6.50– 7.00	July, 1919	7.00– 8.00
Mar. 29, 1915	7.00– 8.00	October, 1919	8.00– 8.25
June 28, 1915	9.00– 9.50	January, 1920	12.50– 13.00
Sept. 27, 1915	12.00– 14.00	April, 1920	13.50– 13.75
Jan. 3, 1916	12.00– 14.00	July, 1920	12.50– 13.00
Apr. 3, 1916	11.00– 12.00	October, 1920	10.00– 11.50
July 3, 1916	10.00– 10.25		

Thymol—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	18	Thymol	25 per cent ad valorem.

(For acts of 1883 to 1909, see Court and Treasury Decisions, *infra*, and Chloral Hydrate, *supra*.)

Court and Treasury Decisions.

Thymol, or thymic acid, was held exempt from duty as an acid used for medicinal purposes and not dutiable as a chemical compound or salt under the act of 1883.—Appeal, T. D. 8486, revoking T. D. 6348, declaring thymol not to be an acid.

Thymol, classified by the collector as a chemical compound in the preparation of which alcohol had been used, was held upon the record in the particular case not dutiable as a chemical compound in the preparation of which alcohol was not used, under the act of 1909.—United States *v.* National Aniline and Chemical Co. (3 Ct. Cust. Appls., 10) (T. D. 32287), reversing Abstract 24002 (T. D. 30944). Also Abstracts 2 2 3 (T. D. 31478); 25762 (T. D. 31674); 25974 (T. D. 31720); 27374 (T. D. 32089); 34816 (T. D. 34201).

Thymol prepared from oil of thyme was furthermore held not entitled to free entry as oil of thyme nor dutiable as a drug advanced in value or condition under the act of 1909.—Abstract 34702 (T. D. 34165); Abstract 34768 (T. D. 34186).

For the classification under other tariff acts, see page 13 of the Tariff Information Catalogue upon Chloral Hydrate.

CARBON TETRACHLORIDE.

[Par. 19, act of 1913, 1 cent per pound.]

SUMMARY.

Description.—Carbon tetrachloride or tetrachlormethane is a liquid, the vapors of which are very effective in extinguishing fires. This property gives carbon tetrachloride its largest use as a filler for fire extinguishers. It is also used for cleaning silks and gloves; it has no injurious effects on the most delicate fabrics and colors. It also has valuable solvent properties.

Domestic production.—There are no census of production figures on carbon tetrachloride. The industry has had its greatest development since about 1909. This development is due to a normal increase in the consumption for fire extinguishers, in the use as a solvent, and to the cessation of imports.

The raw materials for the manufacture of carbon tetrachloride are coke (carbon), sulphur, and chlorine gas. Sulphur chloride is produced simultaneous in the process and can be recovered as a joint product or it can be used to produce more carbon tetrachloride.

Carbon tetrachloride is produced at Midland, Mich.; Charleston, W. Va.; Niagara Falls, N. Y.; and at Pittsburg, Calif.
The production is on a large scale plant basis.

Imports.—Import figures for carbon tetrachloride are first shown for 1914, when 572,910 pounds were brought in. During 1915, 342,854 pounds were imported. Since 1915 the imports have practically ceased. The imports were from Germany.

Price.—The present price of carbon tetrachloride is about the same as the price prevailing before the war.

Tariff history.—Carbon tetrachloride was first mentioned specifically in the tariff act of 1913, paragraph 19, dutiable at 1 cent per pound.

GENERAL INFORMATION.

Description.—Carbon tetrachloride or tetrachlormethane is a chemical compound of the formula CCl_4. The former name is the one used entirely in commerce, with the exceptions of the trade names of "Carbona" and "Pyrene." This product is a clear, heavy liquid, which has a characteristic pungent odor. It has a specific gravity of 1.604 and weighs 13.3 pounds per gallon. A good grade should be water white, should boil between the temperatures of 76 and 77° C., and should give no residue on evaporation. It is noninflammable, noncombustible, nonexplosive, and a nonconductor of electricity. This latter property makes it very desirable for combating electrical fires.

When exposed to air carbon tetrachloride volatilizes rapidly and its vapors are very effective in extinguishing fires. It is this property that gives this article its widest use. A grade of this article suitable for fire extinguishers should be free from the common impurities, which are carbon disulphide and sulphur chloride. A small percentage of chloroform or ethylene chloride is added to carbon tetrachloride in fire extinguishers to prevent freezing in cold climates.

Carbon tetrachloride has valuable solvent properties for oils, fats, waxes, gums, and resins.

Pure carbon tetrachloride in the absence of water has no corrosive action on iron or the common metals. It is shipped in steel drums holding about 200, 650, and 1,350 pounds. It can also be purchased in 1, 2, 5, and 10 gallon cans.

Raw materials.—The manufacture of carbon tetrachloride requires a supply of carbon, sulphur, and chlorine gas as raw materials. Charcoal (carbon) is obtained as a by-product of the numerous wood-distillation plants in this country. The other raw materials are also produced in large quantities in the United States. (See surveys on Chlorine and Sulphur.)

The introduction of electrolytic chlorine in the manufacture of carbon tetrachloride has greatly cheapened the cost of production of this article and has been one of the important factors in the development of the industry in this country.

Process of manufacture.—The production of carbon disulphide is the first step in the manufacture of carbon tetrachloride. The carbon disulphide is produced by adding molten sulphur to red-hot charcoal, the sulphur is volatilized, and the vapors combine with the charcoal (carbon) to form carbon disulphide, which passes out of the retort and is condensed. There are different types of furnaces for carrying out this operation, including electric ones. The carbon tetrachloride is usually made in this country from the carbon disulphide by the following method:

Chlorine gas is passed into the carbon disulphide in the presence of iron chloride or aluminium chloride as catalyzers. The chlorine and carbon disulphide react to form carbon tetrachloride and sulphur monochloride. If it is desired to obtain the sulphur monochloride as a by-product for sale or for consumption in the plant, it may be separated from the carbon tetrachloride at this point by fractional distillation. Should there be no demand or outlet for the sulphur monochloride, it may be made to react with more carbon disulphide to form additional carbon tetrachloride with the precipitation of sulphur.

The crude carbon tetrachloride is now treated with a solution of caustic soda, lime, or bleaching powder, according to the practice of individual firms, to remove any sulphur compounds. This treatment is followed by a redistillation, which gives a pure product of carbon tetrachloride.

There may be mentioned the method of making carbon tetrachloride by passing carbon disulphide vapors saturated with chlorine through a red-hot porcelain tube. Carbon tetrachloride and sulphur monochloride are produced by this method and are separated by fractional distillation. It is not known that this method is used in the United States.

There have been several patents on manufacturing carbon tetrachloride by the reaction between carbon and calcium chloride or chlorine at a high temperature, the heat being produced by electricity. However, this method has not been used to any extent in commercial practice.

History of the industry.—The carbon tetrachloride industry is one of the more recent chemical industries of the United States. With the introduction of electrolytic chlorine in the manufacture of this chemical the cost of production has been greatly lowered. This has caused a rapid development in the industry since about 1909.

In recent years there has been a normal development in the use of this product for fire-extinguishing purposes, which has been entirely independent of the war.

Prior to the war carbon tetrachloride was imported into this country from Germany and sold under the trade name of "Carbona" for cleansing purposes. With the outbreak of war these imports were shut off, with the result that the dealers were forced to manufacture carbon tetrachloride for their needs. This has resulted in an increased production of this article in the United States.

In addition there has been an increased demand for carbon tetrachloride due to the new uses arising for this article as a solvent, especially in the rubber industry. It is particularly desirable for this purpose wherever it can replace an inflammable solvent, such as benzene.

Important uses.—1. The largest use and the most important use for carbon tetrachloride is for fire-extinguishing purposes. There are several fire extinguishers on the market that use carbon tetrachloride as the fire-extinguishing agent.

2. Carbon tetrachloride is used for cleaning purposes, and for domestic use as a cleaning agent is sold under various trade names such as "Carbona." It has no injurious effect on the most delicate fabrics and colors. It is used largely in the cleaning of silks and gloves.

3. Carbon tetrachloride has found wide application in the rubber industry as a solvent for cements. This is especially true in the cheaper cements, the higher grades requiring high-test gasoline or benzine.

4. It is used to some extent in the extraction of fats and oils from oil seeds, oil cake, tankage, wool, cotton, and other fat-bearing materials.

5. It has some use as a solvent for varnishes.

6. It is used chemically as the basic raw material in the manufacture of chloroform. This is a large use at the present time and will probably increase as there is a direct war demand for acetone (the alternative raw material for making chloroform) which has caused an acute shortage of this article.

Substitutes and rival commodities.—Acetylene tetrachloride and the chloride of methane and ethane are coming into use as solvents and may replace carbon tetrachloride to some extent for this purpose. These articles are manufactured to a certain extent in this country at the present time and further development of these articles may be expected. Acetylene tetrachloride has a disadvantage in that its vapor is poisonous.

For fire-extinguishing purposes there are other chemical extinguishers which may be used as substitutes for the carbon tetrachloride extinguishers in certain cases. They are not as suitable for use against electrical fires as the carbon tetrachloride, and are injurious to clothes.

Carbon tetrachloride—Imports for consumption—Revenue.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	1 cent per pound	572,910	$28,300	$5,729	$0.049	20.24
1915	do	342,854	18,139	3,428	.053	18.90
1916	do					
1917	do	2	2		1.000	1.00
1918	do					
1919	do					
1920	do					

Carbon tetrachloride—Prices, wholesale (cents per pound), spot, New York.

[Oil Paint and Drug Reporter.]

Years.	January.	April.	July.	October.
1912	7.75– 8.25	10 –10½	12 –13	11 –12
1913	9 –10	8 – 8.75	7.75– 8.5	7.75– 8.25
1914	7.5 – 7.75	7¼–7½	7.4 – 7.5	14
1915	14 –15	12 –13	17 –18	15½ –16
1916	18 –20	17 –18	17½ –18	16 –16½
1917	16½ –17	17 –18	17	17
1918	15 –16	15½–16½	15½ –25	30 –32
1919	15 –16	14	–12	10
1920	11 –12	11 –12	10½ –13	13½ –14

Carbon tetrachloride—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1913	19	* * * ; carbon tetrachloride	1 cent per pound.

CHLOROFORM.

[Par. 19, act of 1913, 2 cents per pound.]

SUMMARY.

Description.—Chloroform or trichlormethane is a colorless liquid having a characteristic ethereal odor. The vapors of chloroform when inhaled produce anesthesia; it is this property that gives chloroform its largest use. About 1 per cent of grain alcohol is usually added to chloroform to prevent its decomposition. It is also used as a solvent, as an antiseptic, and in denistry and medicine.

Domestic production.—The production of chloroform increased from 616,670 pounds, valued at $165,604, in 1904, to 1,869,685 pounds, valued at $477,538, in 1909. In 1914 the production had decreased over 500,000 pounds. This decrease may be attributed to the greater use of ether instead of chloroform. Our domestic production has supplied our consumption.

In 1909 New York produced 90 per cent of our total output.

Chloroform may be manufactured from three different raw materials—carbon tetrachloride, acetone, and grain alcohol. The use of carbon tetrachloride was stimulated by the war demands for acetone.

Imports.—The imports of chloroform have been insignificant. The maximum of 2,444 pounds being imported in 1914.

Price.—The price of chloroform at the beginning of 1918 was about three times the normal prewar price.

Tariff history.—Chloroform has carried a specific duty, which by the act of 1883 was 50 cents per pound. This duty has since been gradually reduced to the duty existing under the act of 1913, paragraph 19, 2 cents per pound.

GENERAL INFORMATION.

Description.—Chloroform or trichlormethane is a chemical compound of the formula $CHCl_3$. The former is the name used exclusively in commerce. It is a clear colorless liquid of a characteristic ethereal odor and burning, sweetish taste. The Pharmacopoeia describes it as follows: "A liquid consisting of not less than 99 per cent nor more than 99.4 per cent by weight of $CHCl_3$, and not less than 0.6 per cent nor more than 1 per cent of alcohol." A good grade should be colorless, have a specific gravity of 1.476 at 25° C., and should boil between 61 and 63° C. For anesthetic purposes it should leave no residue on evaporation, should be neutral to test paper, and should give no indication of hydrochloric acid when tested with silver nitrate.

The liquid itself is noninflammable but its vapors can be made to burn. The vapors of chloroform, when inhaled, produce anesthesia; it is this property that gives chloroform its largest use. Specially

purified grades of chloroform come into commerce with the additional designations according to the method of purification. The common ones are Anschutz, purified by distillation from salicylchloroform; and Pictet, purified by freezing.

Chloroform is an important solvent. It dissolves fats, resins, india rubber, sulphur, phosphorus, iodine, alkaloids, and many other organic compounds.

Air and sunlight are liable to cause the slow decomposition of chloroform with the formation of hydrochloric acid, chlorine, and sometimes carbonylchloride. It has been found that ethyl alcohol prevents this decomposition and therefore the addition of about 1 per cent is largely practiced. Thorpe states that carefully purified sulphur will also prevent this decomposition of chloroform.

Raw materials.—Chloroform is manufactured from three different raw materials—carbon tetrachloride, acetone, and grain alcohol. At the present time carbon tetrachloride is probably used more than the other two raw materials. (See Carbon Tetrachloride page 30.) Owing to the direct war demand on acetone, which caused an acute shortage of this material, it is likely that nearly all of the chloroform made during the war was manufactured from carbon tetrachloride. It is doubtful, however, if this abandonment of acetone as a raw material will be a permanent one. The war caused a great increase in the production of acetone and now that the war demand has disappeared it is quite likely that the price of acetone will be low enough to encourage its consumption in the manufacture of chloroform.

The use of grain alcohol in the manufacture of chloroform does not seem to be as prevalent as in the past.

All the carbon tetrachloride used in the manufacture of chloroform is made in this country. In normal times acetone and alcohol are produced in sufficient quantities in the United States for the manufacture of chloroform and the imports of these materials are small compared with quantity manufactured in this country. It would then appear that the manufacturers in this country are independent of foreign countries for their supply of raw materials for the manufacture of chloroform.

Process of manufacture.—(*a*) From carbon tetrachloride: The production of chloroform from carbon tetrachloride consists in the reduction of the carbon tetrachloride to chloroform by the means of nascent hydrogen, which is generated in the carbon tetrachloride. The conversion of the carbon tetrachloride to chloroform proceeds very slowly, and the mixture must be kept in constant agitation for a long period of time. When the carbon tetrachloride has been changed into chloroform, the chloroform is distilled from the retort, condensed, and subjected to purification as described below.

(*b*) From alcohol and acetone: A paper read before the American Institute of Chemical Engineers by Mr. F. W. Frerichs on the manufacture of chloroform from bleaching powder and ethyl alcohol gives the following method of procedure: Ethyl alcohol is diluted to 20 per cent in an iron still. A solution of bleaching powder containing 35 grams per liter is added slowly to the solution of alcohol, which has previously been brought to boiling. The alcohol and bleaching powder react at once to form chloroform, which passes out of the still and is condensed. In actual operation the manufacture

of 100 pounds of chloroform required 1,022 pounds of 35 per cent bleaching powder and 11.53 gallons of 94 per cent alcohol.

Acetone may be used in the above process or chloroform may be made from acetone by the action of chlorine itself instead of the bleaching powder.

For technical uses the chloroform produced by either of the above methods is usually purified by washing first with water, then with sulphuric acid, followed by a redistillation. For anesthetic purposes, where a very pure product is required, the chloroform is usually dried with calcium chloride before it is redistilled. The portion distilling over up to 64° C. is taken as pure chloroform. Other methods of purification are: Pictet's, which consists in separating the chloroform from the impurities by freezing, and Anschutz, which combines the chloroform with salicylic acid and gently heats the salicylchloroform, thus liberating pure chloroform which is condensed.

Besides the above methods of manufacturing chloroform and the subsequent purification of the product there may be mentioned the method of preparing chloroform from chloral by one distillation. One hundred parts of water-free chloral are treated with 300 parts of caustic soda of 1.1 specific gravity. The resulting chloroform is distilled from the mixture and needs no further purification. This method is used to some extent in preparing chloroform for anesthetic purposes, but it has no industrial application.

The manufacture of chloroform requires besides the raw materials considerable steam for distillation purposes and a small amount of power for agitation. Skilled labor is not required in the production, although careful chemical control is required.

Important uses.—1. Anesthetic purposes, which is the largest use.

2. Solvent for resins, fats, gums, sulphur, phosphorous, iodine, alkaloids, and many other organic compounds.

3. Antiseptic.

4. Medicinal purposes, colic, asthma, spasms, quinsy, hysteria, and scarlet fever.

5. Dentistry.

Substitutes and rival commodities.—For anesthetic purposes the chief rival of chloroform is ether. The production of chloroform in 1914 was 535,731 pounds less than in 1909, while the production of ether increased 953,457 pounds during the same period. As there was not an increase in the imports of chloroform but a decrease during these years, it is evident that ether has been replacing chloroform to a marked extent.

Production of chloroform in United States.

[Figures from Federal Census.]

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Pounds.			*Pounds.*	
1899	396,540	$98,070	1909	1,869,685	$477,538
1904	616,670	165,604	1914	1,333,954	295,317

Chloroform—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1907	20 cents per pound	3,625	$1,575	$725.00	$0.43	46.03
1908	do	2,038	1,128	407.00	.55	36.13
1909	do	1,756	1,231	351.00	.70	28.53
1910	do	45	69	9.00	1.54	13.04
	10 cents per pound	922	1,418	92.00	1.54	6.50
1911	do	1,010	1,782	101.00	1.76	5.67
1912	do	925	1,541	92.00	1.66	6.01
1913	do	942	1,643	94.00	1.74	5.73
1914	do	170	421	17.00	2.48	4.04
	2 cents per pound	2,274	569	45.00	.25	8.00
1915	do	26	43	52.00	1.65	12.09
1916	do					
1917	do					
1918	do	1	1	.02	1.00	2.00
1919	do	54	40	1.00	.74	2.70
Calendar year:						
1918	do	51	39	1.02	.76	2.62
1919	do	4	2	.08	.50	4.00
1920 [1]	do	2	4	.04	2.00	1.00

[1] From Jan. 1 to July 1, 1920.

Chloroform—Prices, wholesale (cents per pound), spot, New York.

[From Oil Paint and Drug Reporter.]

Years.	January.	April.	July.	October.	Years.	January.	April.	July.	October.
1912	23–28	20–25	20–25	20–25	1917	60–65	60–65	60–65	60–65
1913	25–30	25–30	25–30	25–30	1918	[1] 63–68	[1] 63–68	[1] 63–68	[1] 63–70
1914	25–30	19–24	19–24	30–35	1919	[1] 48–49	43–44	30–31	
1915	30–35	30–35	30–35	35	1920	30–31	35–36	40–45	[1] 43–45
1916	60–65	70–75	44–50	50–55					

[1] U. S. Pharmacopœia.

Chloroform—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	104	Chloroform	50 cents per pound.
1890	17	do	25 cents per pound.
1894	13	do	Do.
1897	14	do	Do.
1909	14	do	10 cents per pound.
1913	19	do	2 cents per pound.

Court and Treasury Decisions.

Chloroform in small cylindrical glass vessels 2 by ¾ inch, sealed on one end, with a small, thin glass bulb to prevent evaporation, was held by the classification committee at New York, May 8, 1918, to be dutiable at 25 per cent ad valorem under paragraph 17 of the act of 1913 as a medicinal substance in ampoules and not as chloroform under paragraph 19.

SULPHUR CHLORIDES.

[Par. 5, n. s. p. f., act of 1913, 15 per cent ad valorem.]

SUMMARY.

Description.—There are two commercial grades of sulphur chlorides, designated according to their color as sulphur chloride yellow and sulphur chloride red. The yellow product is sulphur monochloride and the red product is sulphur monochloride containing additional chlorine. The properties of the two varieties are very similar, the red product possessing greater oxidizing powers. Sulphur chloride is used in the "cold process" of vulcanizing rubber, in the manufacture of acetic anhydride, in the chlorination of organic compounds, and in the vulcanization of certain oils.

Domestic production.—Sulphur chloride is obtained as a by-product in the manufacture of carbon tetrachloride or it is prepared by passing chlorine gas over molten sulphur.

The amount of sulphur chloride that can be produced as a by-product of carbon tetrachloride is greater than our domestic requirements. Figures of actual production are not available for recent years. Sulphur chloride is produced by at least five firms in the United States.

Prices.—Sulphur chloride has been quoted consistently at about 6 and 6½ cents per pound in drums.

Tariff history.—Sulphur chloride has not been mentioned by name in any of the tariff acts.

GENERAL INFORMATION.

Description.—There are two grades of sulphur chloride recognized in commerce. These are designated according to their color as sulphur chloride yellow and sulphur chloride red. The yellow product is sulphur monochloride, which has the chemical formula S_2Cl_2. The red product is regarded by some authorities as a mixture of sulphur monochloride (S_2Cl_2) and sulphur dichloride (SCl_2), containing about 60 per cent of the latter. Other authorities regard the red product as sulphur monochloride containing free chlorine in solution.

Sulphur monochloride is a clear amber-colored heavy liquid. It has a specific gravity of about 1.70 and it weighs approximately 14.2 pounds per gallon. It boils between 137 and 140° C. Sulphur monochloride will dissolve sulphur to the extent of about 67 per cent. A good commercial grade should not contain over 5 per cent free sulphur, because free sulphur is a useless adulterant in most cases.

The chemical properties of the two varieties of sulphur chloride are very similar. The red product is a stronger oxidizing agent. Sulphur chloride acts on many metals, such as iron, tin, aluminum, and mercury-producing chlorides. Most of the metallic oxides when heated in the vapor of sulphur chloride yield chlorides of the metal free from oxychlorides.

Sulphur chloride fumes strongly when exposed to the air, due to the decomposition of the vapors by the moisture. Hydrochloric acid gas, sulphur, and sulphur dioxide are the products formed by combination with water. Owing to this formation of hydrochloric acid in the presence of water, sulphur chloride must be shipped either in iron drums which have been thoroughly dried and sealed air-tight after filling or in glass carboys. In the shipment of large quantities of sulphur chloride iron drums containing about 600 or 1,300 pounds are used. In the case of small shipments glass carboys are employed.

Sulphur tetrachloride (SCl_4) is known, but it has no industrial application.

Important uses.—Sulphur monochloride is used in the vulcanization of rubber goods, usually in solution with carbon tetrachloride, carbon disulphide, or benzene. This process of vulcanization, which is known as the "cold" process, can only be used on rubber articles in thin sheets, such as tobacco pouches and the like. This use has been decreasing and is relatively small at the present time.

Since the development of the cellulose acetate industry sulphur chloride has been used largely in the manufacture of acetic anhydride, which is needed in the manufacture of cellulose acetate. This use will probably be the largest use in the near future if it is not already.

Sulphur chloride may be used in the manufacture of organic chlorination products, and the development of this use is to be expected.

It can be used in the preparation of metallic chlorides when it is desired to obtain a product free from oxychloride.

It is used in vulcanizing oils which are to be used in the manufacture of rubber substitute.

Raw materials.—A large proportion of the sulphur chloride produced in this country is as a by-product of the manufacture of carbon tetrachloride. In the case of the direct manufacture of sulphur chloride the raw materials are sulphur and chlorine gas. For the production of these raw materials in the United States the reports on these products should be consulted.

Process of manufacture.—For the production of sulphur chloride as a by-product the report on carbon tetrachloride should be consulted.

The direct method of manufacturing sulphur chloride consists in passing dry chlorine over molten sulphur. The chlorine gas is usually dried by means of sulphuric acid. It is then passed into an iron vessel containing molten sulphur, which is kept at a temperature just above the boiling point of sulphur monochloride. The chlorine and sulphur combine to form sulphur monochloride, which immediately distills out of the vessel and is condensed. The product at this point is mainly sulphur monochloride containing small amounts of sulphur dichloride. To obtain the red sulphur chloride the sulphur monochloride is now saturated with chlorine gas.

The sulphur chloride is then placed in drums or glass carboys for shipment. Great care must be taken in using iron drums to see that they are perfectly dry, as any moisture present will form hydrochloric acid, which will eat holes in the drums. The drums are usually dried by means of hot dry air just before being filled with the sulphur chloride. If glass carboys are used, they should be well

packed to prevent breakage. Any leakage or breakage of sulphur chloride containers during shipment is very injurious to other articles that may be in the shipment or to the workman that must handle the shipment.

Tariff consideration.—There is no tariff problem connected with sulphur chloride. It can be produced in this country in sufficient quantities to meet the demand as a by-product of carbon tetrachloride.

Sulphur chloride—Production in United States—"Official source."

[Figures from Federal Census.]

Year 1899:		
Quantity	pounds..	10. 000
Value		$3. 500

NOTE.—Not listed separately since the census of 1899.

PARAGRAPH 20, 21, 22, AND 23.

This paragraph, together with paragraphs 21, 22, and 23 of Schedule A, and paragraphs 394, 452, and 514 of the free list, and the words "salicylic acid," in paragraph 1, and "carbolic" and "phthalic" in paragraph 387, were expressly repealed by Title V of the act of September 8, 1916, which in general covers dyes and other chemicals of coal-tar origin. This whole subject has been discussed in four reports of the United States Tariff Commission, entitled, respectively, "Census of Dyes and Coal-Tar Chemicals, 1917," "Dyes and Other Coal-Tar Chemicals," "Census of Dyes and Coal-Tar Chemicals, 1918," and "Census of Dyes and Coal-Tar Chemicals, 1919."

COBALT OXIDE.

[Par. 24, act of 1913, 10 cents per pound.]

General Information.

Cobalt oxide is the most important compound of the comparatively rare metal cobalt. Practically all of the world's supply of this metal and its compounds comes from mines in the vicinity of the town of Cobalt in Ontario, Canada. Here the minerals of cobalt are obtained as a by-product of silver mining. Zaffer (par. 657, free list) is a natural mineral, which is an impure cobalt oxide.

The most important use of cobalt oxide is as a blue coloring agent for glass and porcelain and pottery and as a constituent of blue enamels for iron or steel and other metals. There is no other substance which rivals cobalt oxide for this use. Cobalt oxide is also used in the manufacture of blue pigment smalt as a drier in some varieties of paints and varnishes. It is also used in the preparation of cobalt salts, which are, however, of little commercial importance.

The metal cobalt has been of minor importance in the past, but recent investigations have developed uses which seem likely to cause a rapid increase in the demand. (See Survey on Cobalt Metal, par. 453.)

Cobalt, oxide of—Imports for consumption—Revenue.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	25 cents per pound	22,533	$32,686	$5,633	$1.45	17.23
1909	do	6,361	8,549	1,590	1.34	18.60
1910	do	8,207	8,500	2,051	1.03	24.14
1911	do	14,561	7,576	3,640	.52	48.05
1912	do	22,160	10,822	5,540	.48	51.19
1913	do	28,729	14,405	7,182	.50	50.55
1914	do	8,057	4,841	2,014	.60	41.61
	10 cents per pound	101,427	90,185	10,142	.88	11.25
1915	do	190,155	180,087	19,015	.94	10.56
1916	do	238,934	228,745	23,893	.95	10.44
1917	do	236,822	220,263	23,682	.93	10.75
1918	do	220,863	248,172	22,086	1.12	8.90
1919	do	143,003	215,441	14,300	1.50	6.64

Cobalt, oxide of—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty specific and ad valorem.
1883	50	Cobalt, oxide of	20 per cent ad valorem.
1890	20	do	30 cents per pound.
1894	14½	do	25 cents per pound.
1897	16	do	Do.
1909	16	do	Do.
1913	24	do	10 cents per pound.

PYROXYLIN PLASTICS.

[Par. 25, act of 1913.]

SUMMARY.

Description.—Pyroxylin is the name applied to the soluble nitrates of cellulose. Collodion is a solution of pyroxylin in alcohol and ether. Pyroxylin plastics are substances composed of pyroxylin and camphor. They are sold under different trade names, such as "celluloid," "fiberoid," "viscoloid" and "pyralin."

Uses.—Collodion is used for coating wounds, abrasions, boils, etc. Pyroxylin plastics are used for making combs, mirror and brush backs, knife handles, buttons, toys, and many other articles.

Manufacture.—Pyroxylin is made by nitrating a high grade of cellulose, usually tissue paper. The materials used in the manufacture of the plastics are pyroxylin, camphor, alcohol, and substances to be used as pigments and stabilizers. The stabilizer usually used is urea and the pigment, zinc oxide.

Camphor is the most expensive constituent, and the supplies are controlled entirely by Japan, although one company in the United States is at present using synthetic camphor manufactured in its own plant.

The apparatus used in the manufacture of pyroxylin plastics is expensive, while that used in the manufacture of finished articles made from the plastic is comparatively simple and inexpensive.

Domestic production.—The domestic production of pyroxylin plastics in the United States has increased greatly in the past 20 years. In 1899 the total value of such articles was $1,526,572. In 1909 it was $5,682,379, and by 1914 had increased to $8,876,509. In 1918 all the pyroxylin plastics manufactured in the United States were produced by four companies.

Imports.—Imports of pyroxylin plastics not made into finished or partly finished articles have not averaged more than 1 per cent of the domestic production, but showed a marked increase after the act of 1913 reduced the duty on this substance. Imports of the partly or wholly finished manufactured articles amounted in 1914 to about 10 per cent of the domestic production, having shown a decided increase after the reduction of duty by the act of 1913. Since the beginning of the war the imports from Europe have almost ceased.

Exports.—From 1910 to 1914 the value or exports of "celluloid, and manufactures of," averaged about $1,500,000 annually. In 1918 the exports were valued at $3,744,745.

Foreign production.—Before the war Germany was the largest producer of pyroxylin, with the United States, England, France and Japan ranking in the order named. Japan seems likely to become the chief competitor of the United States since that country controls the world's supply of camphor.

Prices.—Before the war pyroxylin sold for about 70 cents per pound, and in 1918 was selling at about $1 per pound.

General Information.

Description.—Pyroxylin plastics are substances composed of soluble nitrocellulose and camphor. The soluble nitrocelluloses contain a lower per cent of nitrogen than those used in the manufacture of explosives. These plastics are inflammable but not explosive under ordinary conditions and are softened by heat so that they may be molded into any desired form. They may be made transparent or by the addition of suitable pigments, they may be colored as desired or made opaque. These plastics are sold under different trade names, such as "celluloid," "fiberloid," "viscoloid," and "pyralin."

Moving-picture films are quite different in composition, as they contain only 2 or 3 per cent of camphor. They are not plastics and are made by an entirely different process.

Uses.—Pyroxylin plastics are used for making combs, brush, and mirror backs, knife handles, buttons, rims of eyeglasses, piano keys, penholders, chessmen, boxes, toys, and many other articles.

These substances do not compete to any great extent as yet with the phenolic resins such as "Bakelite." These are used mostly where a noninflammable material is necessary.

Manufacture.—The materials used in the manufacture of pyroxylin plastics are nitrocellulose, camphor, alcohol, and substances to be used as pigments and stabilizers. The stabilizer usually used is urea and the pigment zinc oxide. Camphor is the most expensive constituent. The supplies of natural camphor are controlled entirely by Japan. In recent years synthetic camphor has been produced in this country from turpentine. Before the war the urea used was obtained entirely from Germany, but American companies are now supplying the market.

The nitrocellulose is made from a very pure grade of unglazed paper, preferably tissue paper, which is usually subjected to bleaching before final washing. The nitrocellulose is then finely pulped in order that it may be absolutely uniform. Then to 100 parts of pyroxylin are added 40 parts of alcohol, about 35 parts of camphor, and from one-half to 2 parts of stabilizer, such as urea. The amount of zinc oxide added in some cases may be as high as 20 per cent of the total. These substances are then intimately mixed in a kneading machine. After the constituents have been thoroughly incorporated the mixture is run between slightly heated rolls and pressed into sheets. These sheets are then pressed together in a hydraulic press heated to about 70° C. and made into a solid cake. From this cake sheets of the desired thickness may be cut or it may be formed into rods, tubes, blocks, or into any desired shape by heated hydraulic presses. This plastic material is then freed from excess solvent and is seasoned by drying in fireproof rooms at 30° C. for from one to six weeks, or longer, according to thickness. The product thus obtained is either worked into finished articles at the factory where it was produced or is sold to other companies which manufacture only the finished articles.

Domestic production.—The domestic production of pyroxylin plastics has increased rapidly in the United States in the past 20 years. The value of such articles which in 1899 amounted to $1,526,572 had increased to $5,682,379 in 1909, and in 1914 the total value was $8,876,509, of which $5,098,135 represented finished articles manu-

factured in the producing establishments. In 1918 all the pyroxylin plastics manufactured in the United States were produced by four companies, which sold a part of their product to other companies as well as manufacturing some of it into finished articles.

Imports.—The imports of pyroxylin plastics not made into finished articles have averaged less than 1 per cent of the domestic production, although the increase was marked following the reduction of duty in 1913. The imports for 1914 amounted to 118,980 pounds, valued at $59,270. Since the beginning of the war the imports have fallen off greatly and during 1918 amounted to only 1,349 pounds, valued at $1,343.

Imports of partly or wholly finished articles manufactured from pyroxylin compounds have been greater, amounting in 1914 to about 10 per cent of the domestic production of such articles. As in the case of the crude plastic, the increase of imports was marked after the reduction of duty in 1913. The imports for 1913 were valued at $267,502, while in 1914 the imports amounted to $521,175. After the beginning of the war the imports from Europe almost ceased, so that the imports for 1918 amounted to only $49,592.

Exports.—Domestic exports of "celluloid, and manufactures of," have shown a decided increase because the war to a large extent stopped the exports from Europe. From 1910 to 1914 the domestic exports averaged about $1,500,000 annually, while in 1917 the value was more than double that amount. The exports for 1918 were valued at $3,744,745, 1919 at $7,966,493, and for first 9 months of 1920 (calendar year) $7,398,729.

Foreign production.—Before the war Germany was the largest producer of pyroxylin, supplying 40 to 50 per cent of the total output. The United States ranked second and England, France, and Japan in the order named. When the war began the German shipments ceased and the English and French factories devoted most of their equipment to the manufacture of smokeless powder. The Japanese seem to be rapidly gaining in experience in the manufacture of pyroxylin plastics, and Japan probably will become the chief competitor of the United States, since it controls the world's supply of camphor, which is the most expensive constituent of these plastics. One company manufacturing pyroxylin plastics is at present making synthetic camphor which is used by it, and is therefore independent of the Japanese supply.

Tariff history.—Pyroxylin compounds have been specially provided for in all the tariff acts since 1883. The duty on the crude, unshaped product was 50 cents per pound under the acts of 1883, 1890, and 1897, but was reduced to 40 cents per pound by the acts of 1894 and 1909. The act of 1913 made the duty 15 per cent ad valorem.

The duty on pyroxylin compounds made into sheets, blocks, etc., has been more variable, ranging from 60 cents to 45 cents per pound, until the act of 1913 made the duty an ad valorem one of 25 per cent.

For partly finished or finished articles the duty has been specific plus an ad valorem duty, except under the acts of 1894 and 1913. The act of 1894 placed the duty at 45 per cent ad valorem. Under the act of 1913 it is 40 per cent ad valorem.

Prices.—Before the war pyroxylin sold for about 70 cents per pound, and in 1918 was selling at about $1 per pound.

COLLODION.

Description.—Collodion is a solution of nitrocellulose (pyroxylin) in alcohol and ether. It is a clear sirupy liquid which is highly inflammable. On evaporation of the solvent it leaves a film of nitrocellulose.

Flexible collodion is simple collodion with small amounts of castor oil and Canada balsam, or camphor, added. On drying it is more flexible than ordinary collodion. Cantharidal collodion contains cantharides, acetone being used as the solvent.

Uses.—Collodion is used in surgery for coating wounds, abrasions, boils, etc. Flexible collodion is used where a flexible covering is desired as it does not shrink on drying as does ordinary collodion Cantharidal collodion is used where it is desired to produce a blistering effect, as in the case of severe neuralgic pains, pneumonia, etc Various preparations of collodion are sold under special trade names, such as "Heal All," "Heal Skin," "Fluid Skin," and "Nu-Skin," Collodion is also used in the preparation of some photographic plates.

Manufacture.—Collodion is made by dissolving soluble nitrates of cellulose in ether and alcohol or some other convenient solvent. The lower nitrates, known as pyroxylin, are used. Pyroxylin is prepared by treating pure cellulose, such as tissue paper, or cotton waste with the proper mixture of nitric and sulphuric acids. (For further details see page 43.)

Domestic Production.—Separate figures for the production of collodion are not obtainable but are included in the total figures for pyroxylin compounds.

Imports.—Imports of collodion and other solution of pyroxylin have never been large. In 1913 the imports amounted to 523 pounds valued at $2,298. In 1914 the total value was $2,936. In 1918 $2,109 worth was imported.

Exports.—No exports of collodion are shown in Commerce and Navigation.

Prices.—The price of collodion was fairly constant at about 35 cents per pound from 1914 to the middle of 1917 when it began to increase and by December, 1917, it was quoted at 45 and 47 cents per pound due to use in war surgery and to the withdrawal of Germany as the largest producer of pyroxylin which combined with alcohol and ether makes collodion. By July, 1920, it had dropped to 30 cents as not so much was needed as in war time for surgical purposes. Flexible collodion has shown a great change in price from 35 to 40 cents per pound in January, 1916, to 70 to 72 cents by January, 1918. The rise due to same causes that affected collodion. In July, 1920, the price of flexible collodion had decreased to 35 and 36 cents per pound.

Tariff history.—Collodion has been dutiable since the tariff act of 1883. Under the acts of 1883, 1890, and 1897, collodion was dutiable at 50 cents per pound while the acts of 1894 and 1909 placed a duty of 40 cents per pound on this substance. The act of 1913 made the duty an ad valorem one of 15 per cent.

Japanese[1] *production of celluloid and manufacturers of—Production in principal foreign countries.*

1915	$661,326
1916	1,705,527
1917	3,295,187
1918	7,188,017

[1] From the Thirty-fifth Statistical Report of the Department of Agriculture and Commerce, Japan. Yen converted at par value of $0.4985.

Collodion and all other liquid solutions of pyroxylin or of other cellulose esters or of cellulose [1]—Imports for consumption—Revenue.

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1910	40 cents per pound	3,956	$2,929	$1,582.00	$0.74	54.08
1911	do	434	785	173.00	1.81	22.11
1912	do	393	218	157.00	.55	72.11
1913	do	523	2,298	209.00	4.39	9.10
1914	do	247	911	98.00	3.69	10.84
	15 per cent		2,025	303.00		15.00
1915	do		831	124.00		15.00
1916	do		1,277	191.00		15.00
1917	do		10	1.00		15.00
1918	do		2,109	316.00		15.00
1919	do					
Calendar year:						
1918	do		51	7.65		15.00
1919	do	226	344	51.60	1.52	15.00
1920 [2]	do	542	321	48.15	.59	15.00

[1] Prior to act of 1913, described as "Collodion and all compounds of pyroxylin or other cellulose esters."
[2] From Jan. 1 to July 1, 1920.

Compounds of pyroxylin and other cellulose esters—Imports for consumption—Revenue.

POLISHED, WHOLLY OR PARTLY, OR IN FINISHED OR PARTLY FINISHED ARTICLES (ACTS OF 1909 AND 1913).

	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal years:		*Pounds.*				*Per cent.*
1910	65 cents per pound plus 30 per cent.	54,903	$140,206	$77,749	$2.55	55.45
1911	do	55,041	129,112	74,510	2.35	57.71
1912	do	83,252	184,819	109,559	2.22	59.28
1913	do	125,006	267,502	161,504	2.14	60.38
1914	do	50,740	107,632	65,271	2.12	60.64
	40 per cent		413,542	165,416		40.00
1915	do		340,722	136,288		40.00
1916	do		123,028	49.211		40.00
1917	do		52,979	21,191		40.00
1918	do		49,532	19,836		40.00
1919	do	31,579	40,026	16,010	1.27	40.00
Calendar year:						
1918	do		44,846	17,938		40.00
1919	do	26,482	51,340	20,536	1.93	40.00
1920 [1]	do		31,198	12,479		40.00

IN BLOCKS, SHEETS, RODS, TUBES, OR OTHER FORMS, NOT POLISHED AND NOT MADE UP INTO FINISHED OR PARTLY FINISHED ARTICLES (ACTS OF 1909 AND 1913).

Fiscal years:		*Pounds.*				*Per cent.*
1910	45 cents per pound	2,975	$2,577	$1,338	$0.866	51.95
1911	do	1,165	2,270	524	1.948	23.10
1912	do	1,178	2,641	530	2.241	20.07
1913	do	22,305	18,838	10,037	.844	53.28
1914	do	1,998	1,748	899	.875	51.44
	25 per cent	116,981	57,522	14,380	.492	25.00
1915	do	60,314	30,161	7,540	.500	25.00
1916	do	8,284	3,322	830	.401	25.00
1917	do	401	604	151	1.505	25.00
1918	do	1,349	1,343	335	.995	25.00
1919	do	3,628	3,146	787	.868	25.00
Calendar year:						
1918	do	4,977	4,489	1,122	.901	25.00
1919	do	5,234	6,217	1,554	1.188	25.00
1920 [2]	do	3,587	5,000	1,250	1.395	25.00

[1] From Jan. 1 to July 1, 1920.
[2] Jan. 1 to June 30, 1920.

Celluloid, and manufactures of—Domestic exports.

FISCAL YEARS.

Exported to—	1909	1910	1911	1912	1913	1914
Belgium	$2,068	.....	$147,083	$699,991	$600,360	$760,199
France	.....	$3,379	22,758	400,265	405,275	24,009
United Kingdom	364,682	890,461	1,225,267	519,432	327,710	380,764
Canada	142,896	167,667	189,247	197,967	170,174	140,570
All others	78,213	127,573	109,859	216,716	135,527	81,999
Total	587,859	1,189,080	1,694,214	2,034,371	1,639,046	1,387,541

Exported to—	1915	1916	1917	1918
Belgium	$69,230	.....	.....	.....
France	21,900	$359,296	$827,317	$1,084,599
United Kingdom	359,559	1,052,344	906,302	1,034,236
Canada	125,139	323,285	555,131	755,747
All others	148,982	593,217	823,691	870,163
Total	722,850	2,328,142	3,112,441	3,744,745

CALENDAR YEARS.

Exported to—	1918	1919	1920 [1]
Belgium	.....	$228,385	.....
France	$1,212,826	2,573,825	.....
United Kingdom	1,578,442	1,941,792	.....
Canada	849,533	1,106,836	.....
All others	1,040,646	2,115,655	.....
Total	4,680,947	7,966,493	$8,079,307

[1] From January to Oct. 31, 1920. Not stated by countries.

Exports of celluloid and manufactures of, from Japan, by fiscal years.

	1917		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Celluloid.						
Exported to:						
Great Britain	855,907	$474,605	352,871	$207,142	.....	.....
France	58,584	39,895	915,629	573,043	.....	.....
United States	.....	.....	14,270	9,608	.....	.....
All other	42,046	29,827	55,707	47,278	.....	.....
Total	956,537	544,330	1,339,477	837,071	1,354,457	$1,104,465
Celluloid manufactures.						
Exported to:						
China	.....	17,189	.....	25,322	.....	.....
British India	.....	9,397	.....	14,304	.....	.....
Dutch India	.....	3,988	.....	12,177	.....	.....
Great Britain	.....	5,929	.....	13,303	.....	.....
United States	.....	8,179	.....	5,934	.....	.....
Australia	.....	2,203	.....	15,555	.....	.....
Hawaii	.....	7,848	.....	20,075	.....	.....
All other	.....	18,811	.....	38,782	.....	.....
Total	.....	73,544	.....	145,452	.....	95,884

Collodion, flexible [1]*—Prices, wholesale, per pound, New York, spot.*

[From Oil Paint and Drug Reporter.]

	Cents.		Cents.
Sept. 27, 1915	33–35	April, 1918	70–72
Jan. 3, 1916	35–40	Dec. 31, 1918	65–70
Apr. 3, 1916	39–44	January, 1919	65–70
July 3, 1916	39–44	April, 1919	45–47
Oct. 2, 1916	39–44	July, 1919	42–43
December, 1916	39–44	October, 1919	40–41
January, 1917	39–44	January, 1920	35–36
April, 1917	39–44	April, 1920	35–36
Oct. 1, 1917	44–46	July, 1920	35–36
Dec. 31, 1917	70–72	October, 1920	35–36
January, 1918	70–72	December, 1920	32–36

[1] Not quoted prior to 1915.

Collodion, U. S. P.[1]*—Prices, wholesale, per pound, New York, spot.*

[Oil Paint and Drug Reporter.]

	Cents.		Cents.
Sept. 27, 1915	28–30	Apr. 1, 1918	45–47
Jan. 3, 1916	30–32	Dec. 31, 1918	41–45
Apr. 3, 1916	33–38	January, 1919	41–45
July 3, 1916	33–38	April, 1919	40–41
Oct. 2, 1916	30–38	July, 1919	37–38
December, 1916	30–38	October, 1919	34–35
January, 1917	33–38	January, 1920	30–31
April, 1917	33–38	April, 1920	30–31
Oct. 1, 1917	38–40	July, 1920	30–31
Dec. 31, 1917	45–47	October, 1920	30–31
January, 1918	45–47	December, 1920	32–34

[1] Not quoted prior to 1915.

Collodion and celluloid—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	105	Collodion, and all compounds of pyroxylin, by whatever name known.	50 cents per pound.
		Rolled or in sheets, but not made up into articles	60 cents per pound.
		And when in finished or partly finished articles	60 cents per pound and 25 per cent ad valorem.
1890	21	Collodion, and all compounds of pyroxylin, by whatever name known.	50 cents per pound.
		Rolled or in sheets but not made up into articles	60 cents per pound.
		If in finished or partly finished articles	60 cents per pound and 25 per cent ad valorem.
1894	15	Collodion, and all compounds of pyroxylin, by whatever name known.	40 cents per pound.
		Rolled or in sheets but not made up into articles	50 cents per pound.
		If in finished or partly finished articles	45 per cent ad valorem.
1897	17	Collodion, and all compounds of pyroxylin, whether known as celluloid or by any other name.	50 cents per pound.
		Rolled or in sheets, unpolished and not made up into articles.	60 cents per pound.
		If in finished or partly finished articles and articles of which collodion or any compound of pyroxylin is the component material of chief value.	65 cents per pound and 25 per cent ad valorem.
1909	17	Collodion, and all compounds of pyroxylin or of other cellulose esters, whether known as celluloid or by any other name.	40 cents per pound.
		If in block, sheets, rods, tubes, or other forms, not polished, wholly or partly, and not made up into finished or partly finished articles.	45 cents per pound.
		If polished, wholly or partly, or if in finished or partly finished articles, except moving-picture films, of which collodion or any compound of pyroxylin or of other cellulose esters, by whatever name known, is the component material of chief value.	65 cents per pound and 30 per cent ad valorem.
1913	25	Collodion, and all other liquid solutions of pyroxylin, or of other cellulose esters or of cellulose.	15 per cent ad valorem.
		Compounds of pyroxylin or of other cellulose esters, whether known as celluloid or by any other name, if in blocks, sheets, rods, tubes, or other forms, not polished wholly or partly and not made into finished or partly finished articles.	25 per cent ad valorem.
		If polished wholly or partly, or if finished or partly finished articles of which collodion or any compound of pyroxylin or other cellulose esters, by whatever name known, is the component material of chief value.	40 per cent ad valorem.

COURT AND TREASURY DECISIONS.

There has been much litigation upon pyroxylin and its products. The leading cases only will be given.

The provision in paragraph 17 of the act of 1897 for celluloid "rolled or in sheets, unpolished, and not made up into articles," was held not to include sheets of celluloid polished on both sides.—United States *v.* Eschwege, 98 Fed. 600, reversing 91 Fed. 754 and affirming G. A. 4621 (T. D. 21881).

The omission of the words "and articles" from the provision under which the celluloid sheets were classified, to wit, "finished or partly finished articles, and articles of which collodion or any compound of pyroxylin is the component material of chief value," was held not to take articles made *wholly* of pyroxylin or celluloid out of paragraph 17 of the act of 1909.—Canvigny Brush Co. *v.* United States, 1 Ct. Cust. Appls., 118 (T. D. 31118), affirming G. A. 7022 (T. D. 30634).

Hairpins, ping pong balls, sailor in boat, combs, billikens, and "emaillite," a liquid used to make aeroplane canvas water and air proof, and martingale rings and loops are among the articles which have been held dutiable as wholly or in chief value of pyroxylin, celluloid, or collodion rather than under specific provisions, such as metallic pins, jewelry, toys, paint or varnish, and parts of harness.—Claflin Co. *v.* United States, 78 Fed. 805; United States *v.* Strauss Bros. & Co., 136 Fed. 185, reversing 128 Fed. 473; Thomas *v.* Schwarz, 140 Fed. 989 (T. D. 27065); United States *v.* Wanamaker, 136 Fed. 266; G. A. 5975 (T. D. 26184); G. A. 6383 (T. D. 27423); Abstract 29777 (T. D. 32830); Abstract 34318 (T. D. 34026); G. A. 7739 (T. D. 35529). On the other hand, hand-decorated booklets with pyroxylin covers and paper inserts, pyroxylin in chief value, were classified as booklets decorated in whole or in part by hand, and small paper cutters as toys, and not as manufactures of pyroxylin.—United States *v.* Hagelberg, 3 Ct. Cust. Appls., 341 (T. D. 32626), affirming G. A. 7301 (T. D. 32019); Abstract 40932. Booklets, whether or not decorated, in chief value of pyroxylin, were held to come within paragraph 329 as books or printed matter. (G. A. 7917, T. D. 36484; Abstracts 40262 and 41806.)

Celluloid sheets, tubes, and rods, not subjected to any process designed to polish them, but polished to some extent as an incident to smoothing and straightening, were held to fall within paragraph 25 of the act of 1913, as not polished wholly or partly.—United States *v.* Cohn Co., 6 Ct. Cust. Appls., 426 (T. D. 35979), affirming G. A. 7701 (T. D. 35245).

Duty was taken on the total weight and value.—G. A. 6368 (T. D. 27347); G. A. 7167 (T. D. 31296).

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COLORING FOR BRANDY, WINE, BEER, AND OTHER LIQUORS.

(Par. 26, Act of 1913, 40 per cent ad valorem.)

General Information.

Description.—The coloring in brandy, wine, beer, and other potable liquors, such as whisky, rum, gin, and bitters, is due either to the raw materials used in the preparation of the beverage or to an artificial coloring matter which has been added to imitate the natural coloring in order to increase the sale of the product.

The materials generally added to beverages for the purpose of artificially coloring them are usually of vegetable origin, although such coal-tar dyes as have been certified under the provisions of the Federal food and drug act are sometimes used for this purpose.

Brandy is almost invariably colored by adding caramel (burnt sugar) to it, whereas wine, if properly made, requires no artificial coloring matter. The grape skins (with the exception of white grapes) contain a natural coloring matter called œnocyanin or cyanin. Beer, ale, porter, and other malt beverages are colored by the malt, the coloring being caused by the formation of caramel when the malt is heated. The intensification of this color depends, therefore, upon the temperature of the heat treatment. When the color of caramelized malt is extracted and evaporated to a sirupy consistency it is commercially known as "Malt color." Whisky is usually colored by adding caramel, although some color is extracted from the charred wood containers. Rum is colored by adding caramel to it, whereas a sophisticated rum is colored with certified coal-tar dyes. Caramel, certified coal-tar dyes, and to a limited extent such vegetable dyes as saffron, cudbear, turmeric, and chlorophyle are all used in coloring cordials and liquors. An alcoholic infusion of nettles is also sometimes used for this purpose.

Sloe gin is ordinary gin artificially colored by the addition of sloe berries. Bitters are colored by natural herbs and other vegetable coloring matters.

Prohibition in this country will divert the coloring matters to other industries, although it is quite possible considerable use will be made of these materials in nonintoxicating beverages.

Domestic production.—Production statistics of caramel for use in coloring beverages are not known and would be difficult to determine. Caramel is also used in the coloring of various confections, medicinals, and for other purposes. It is made by heating sugar to about 210° C. Such coal-tar dyes as may be used in coloring beverages are now being made here in considerable quantities.

Imports.—The imports of materials used in coloring beverages reached a maximum in 1912 with a value of $3,383, yielding a revenue of $1,691. Late years show a marked decrease in the imports of these articles until in 1917 the importation was valued at only $225 with a revenue of $90.

Tariff history.—These commodities have been dutiable at 50 per cent ad valorem since the tariff act of 1894. In the act of 1913 the rate of duty for them was reduced to 40 per cent ad valorem.

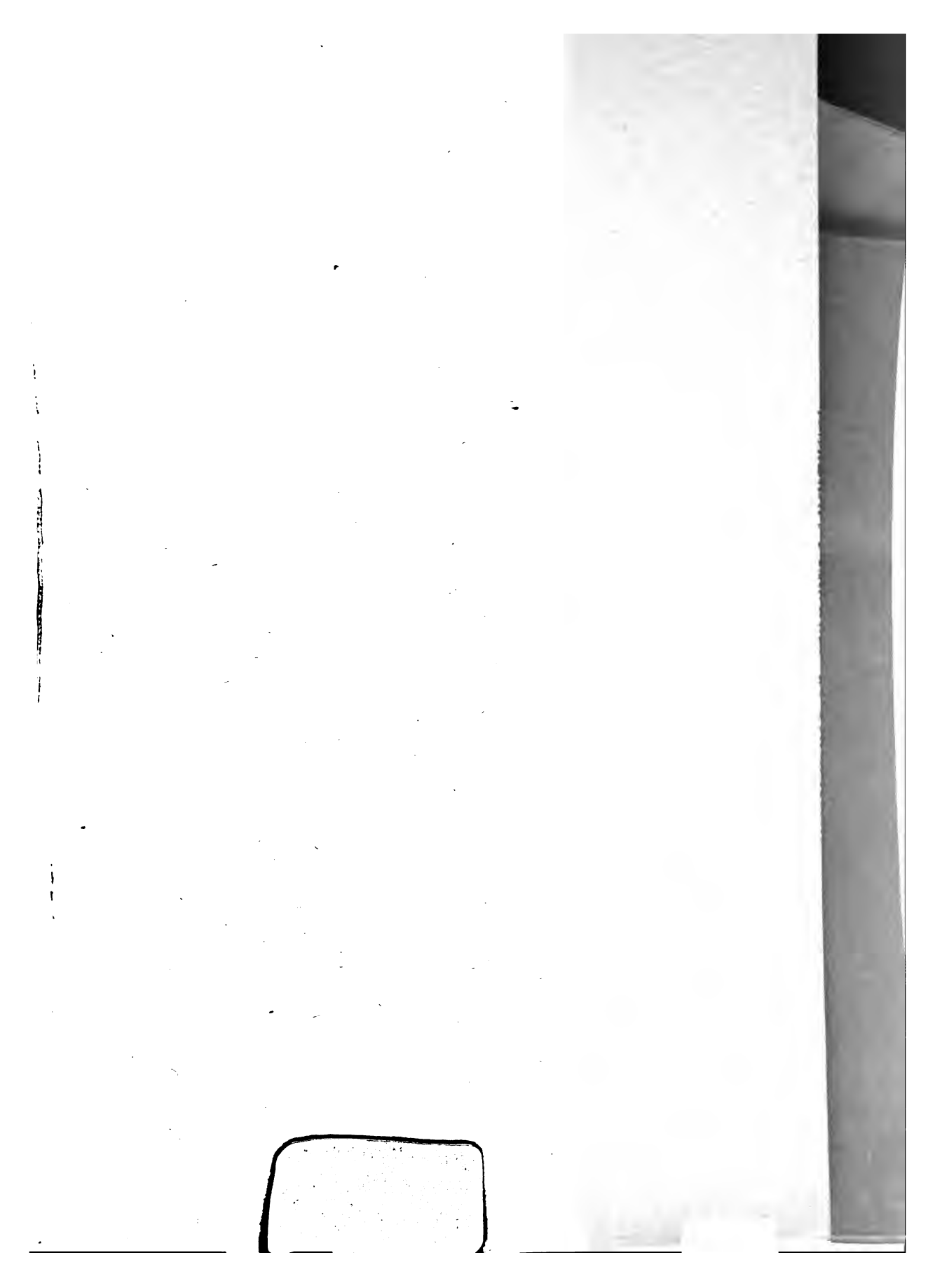
Coloring for brandy, wine, beer, or other liquids.

IMPORTS FOR CONSUMPTION—REVENUE.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1908	50 per cent		$561	$280		50.00
1909	do		704	352		50.00
1910	do		1,171	585		50.00
1911	do		2,637	1,318		50.00
1912	do		3,383	1,691		50.00
1913	do		1,925	962		50.00
1914	do		405	202		50.00
1914	40 per cent		1,223	489		40.00
1915	do		842	336		40.00
1916	do		192	76		40.00
1917	do		225	90		40.00

RATES OF DUTY.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	117	Coloring for brandy	50 per cent ad valorem.
1890	22	Coloring for brandy, wine, beer, or other liquors	Do.
1894	16	do	Do.
1897	18	do	Do.
1909	18	do	Do.
1913	26	do	40 per cent ad valorem.



UNITED STATES TARIFF COMMISSION
WASHINGTON

TARIFF INFORMATION SURVEYS

ON THE ARTICLES IN

PARAGRAPHS 68, 69, and 70 OF THE TARIFF ACT OF 1913

AND RELATED ARTICLES IN OTHER PARAGRAPHS

Paragraph 68:
Sponges.

Paragraph 69:
Talc and soapstone.

Paragraph 70:
Vanillin.
Vanilla beans.
Tonka beans.

REVISED EDITION

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Gift
U.S. Tariff Com.
6-4-28

PREFACE.

This is one of a series of Tariff Information Surveys prepared by the United States Tariff Commission and transmitted to the Committee on Ways and Means. The series covers all of the articles and commodities provided for in the tariff act of October 3, 1913, and others not specifically provided for. It is arranged in the numerical order of paragraphs of that act.

In some cases two or more paragraphs have been combined in one pamphlet. In doing this industrial relationship of the articles has been followed when possible. In those instances where a paragraph has been treated under a preceding paragraph of the tariff act, reference is made to this fact at the point where the paragraph appears in numerical order. Where one grade of an article is dutiable and another grade of the same article is on the free list, the article is discussed under the dutiable paragraph, which appears first in numerical order in the tariff act. In certain instances articles of close industrial relationship and which occur in separate paragraphs of the tariff act have been combined under one paragraph for convenience of discussion. Reference is made to this fact at the point where the commodities would naturally occur in numerical order.

The first pamphlet in the series is an "Introduction and index," which contains:

1. An introductory chapter discussing the scope of the series and the general method of treatment.
2. An alphabetical index of the articles provided for in the tariff act of 1913, showing the paragraph of the act in which the article is provided for and, if discussed under a different paragraph, the number of such paragraph.
3. A list of the pamphlets in the series, showing the paragraphs and articles included in each pamphlet.

Thus, by use of this "Introduction and index" the exact location of the discussion relating to a given article or commodity can be ascertained.

In the preparation of this report the Tariff Commission had the services of Dr. Grinnell Jones and Sidney D. Kirkpatrick, of the chemical division of the commission's staff, and of others.

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SPONGES.

[Par. 68, act of 1913.]

General Information.

DESCRIPTION.

Sponges are collected principally in the Mediterranean and Red Seas and waters of the West Indies, Florida, and Central America. The finest sponges are obtained from the Mediterranean, the next in quality from the Red Sea. Supplies for the United States come chiefly from British West Indies, Cuba, and Florida.

Crude sponges are prepared by maceration in cold water for several days and then beaten to break up and remove concretions contained in them. The better grades are treated with a dilute solution of hydrochloric acid to remove remaining calcareous matter and then, if desired, are bleached by chemical means. Sponges are sometimes loaded with chemicals or sugar to increase their weight.

PRODUCTION.

Most of the crude sponges marketed in this country are from the Florida fisheries. The product of these fisheries in 1913 was valued at about $735,000, a little over $615,000 in 1914, and over $920,000 in 1917. In 1918 it was considerably less, about $623,000. This decrease was due partly to the high price of fish, which induced those engaged in sponge gathering to take up fishing. Tarpon Springs, Fla., is the center of American sponge production. New York is the principal distributing center.

IMPORTS.

Imports of crude sponges have averaged a little more than half the domestic production since 1913, in that year valued at $289,642. The value for 1918 was $510,265. Imports of chemically treated or manufactured sponges have been much less, amounting to $38,300 in 1914, $58,797 in 1916, and $27,682 in 1918. Crude sponges come mostly from the British West Indies, Cuba, and Greece.

Sponges and manufactures of—Imports for consumption—Revenue.

SPONGES. (ACTS OF 1897 AND 1909.)

Under general tariff.

	Rates of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—						*Per cent.*
1908	20 per cent		$157,310	$31,462		20.00
1909	do		162,918	32,583		20.00
1910	do		205,688	41,137		20.00
1911	do		183,367	36,673		20.00
1912	do		218,953	43,790		20.00
1913	do		212,463	42,492		20.00
1914	do		43,022	8,604		20.00
From Philippine Islands. (Acts of Mar. 3, 1905, and Aug. 5, 1909.)						
Fiscal year—						*Per cent.*
1909	75 per cent of 20 per cent		$723	$108		15.00
1910	Free		665			
From Cuba (reciprocity treaty, Dec. 27, 1903).						
Fiscal year—						*Per cent.*
1908	20 per cent less 20 per cent		$99,001	$14,240		16.00
1909	do		79,350	12,696		16.00
1910	do		108,518	17,362		16.00
1911	do		73,112	11,697		16.00
1912	do		92,535	14,805		16.00
1913	do		77,179	12,348		16.00
1914	do		21,850	3,496		16.00

SPONGES, NOT ADVANCED BY CHEMICAL PROCESS. (ACT OF 1913.)

Under general tariff.

Fiscal year—						*Per cent.*
1914	10 per cent		$174,041	$17,404		10.00
1915	do		197,135	19,713		10.00
1916	do		294,830	29,483		10.00
1917	do		411,232	41,123		10.00
1918	do		317,900	31,790		10.00
Calendar year—						
1918	do		360,683	36,068		10.00
1919	do		294,866	29,486		10.00
From Philippine Islands. (Act of Oct. 3, 1913.)						
Fiscal year—						*Per cent.*
1916	Free		$19,950			
1917	do		6,633			
1918	do		8,494			
Calendar year—						
1918	do		1,761			
1919	do		750			
From Cuba (reciprocity treaty, Dec. 27, 1903).						
Fiscal year—						*Per cent.*
1914	10 per cent less 20 per cent		$105,169	$8,413		8.00
1915	do		137,117	10,969		8.00
1916	do		139,846	11,187		8.00
1917	do		175,388	14,031		8.00
1918	do		183,871	14,709		8.00
Calendar year—						
1918	do		160,902	12,872		8.00
1919	do		167,282	13,382		8.00

Sponges and manufactures of, Imports for consumption—Revenue—Continued.

SPONGES, NOT ADVANCED BY CHEMICAL PROCESS (ACT OF 1913)—Continued.

From Virgin Islands (act of Mar. 3, 1917).

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—			*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1918	Free		109			
Calendar year—						
1918			134			
1919			0			

SPONGES, BLEACHED AND ADVANCED BY CHEMICAL OPERATIONS. (ACT OF 1913.)

Under general tariff.

Fiscal year—			*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1914	15 per cent		36,166	5,424		15.00
1915	do		41,600	6,240		15.00
1916	do		58,499	8,774		15.00
1917	do		54,833	8,224		15.00
Calendar year—						
1918	do		19,301	2,895		15.00
1919	do		11,289	1,693		15.00

From Cuba (reciprocity treaty, Dec. 27, 1903).

Fiscal year—			*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1914	15 per cent less 20 per cent.		2,134	256		12.00
1915	do		442	53		12.00
1916	do		298	35		12.00
1917	do		244	29		12.00
Calendar year—						
1918	do		0			
1919	do		509	61		12.00

MANUFACTURES OF, OR OF WHICH SPONGE IS THE COMPONENT MATERIAL OF CHIEF VALUE, N. S. P. F.

Fiscal year—			*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1908	40 per cent		91	36		40.00
1909	do		64	25		40.00
1910	30 per cent		100	30		30.00
1911	do		61	18		30.00
1912	do		58	17		30.00
1913	do		266	79		30.00
1914	do		68	20		30.00
	15 per cent		5			
1915	do		8	1		15.00
1917	do		581	87		15.00
1918	do		27,682	4,152		15.00
Calendar year—						
1918			0	0		
1919			0	0		

Sponges—Imports by countries.

Imported from—	1913 (fiscal year).	1919 (calendar year).
British West Indies	$202,282	$521,035
Cuba	114,365	165,195
England	54,979	17,295
Greece	32,017	16,354
Austria-Hungary	5,352	2,517
Turkey in Asia	3,847	
All other	9,121	12,930
Total	421,963	735,326

EXPORTS.

Exports of sponges for the last decade (1910–1919) have averaged about 200,000 pounds per year, with an average value of about $200,000. About half of the total exports are to England and Canada.

Domestic exports of sponges.

	Quantity.	Value.
Fiscal year—	*Pounds.*	
1913	205,484	$177,059
1914	209,470	173,866
1915	117,618	109,635
1916	197,826	165,884
1917	116,131	129,063
1918	130,471	177,210
Calendar year—		
1918	85,957	147,519
1919	371,602	328,131

Sponges—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	10	Sponges	20 per cent ad valorem.
1890	86	....do	Do.
1894	69	Sponges * * *	10 per cent ad valorem.
1897	82	Sponges	20 per cent ad valorem.
		Manufactures of sponges, or of which sponge is the component material of chief value, not specially provided for in this act.	40 per cent ad valorem.
1909	79	Sponges	20 per cent ad valorem.
		Manufactures of sponges, or of which sponge is the component material of chief value, not specially provided for in this section.	30 per cent ad valorem.
1913	68	Sponges: Trimmed or untrimmed, but not advanced in value by chemical processes.	10 per cent ad valorem.
		Bleached sponges and sponges advanced in value by processes involving chemical operations, manufactures of sponges, or of which sponge is the component material of chief value, not specially provided for in this section.	15 per cent ad valorem.

COURT AND TREASURY DECISIONS.

Sponges taken by vessels enrolled or licensed under the United States laws have been held exempt from duty as products of American fisheries. (T. D. 26550, of 1905.) Rubber bath sponges are not within this provision, but dutiable as manufactures of india rubber. (149 Fed., 1022, of 1906.)

Sponges would be placed logically in Schedule N (Sundries) rather than in Schedule A.

TALC AND SOAPSTONE.

General Information.

Provisions in tariff act of 1913.—"69. Talcum, ground talc, steatite, and French chalk, cut, powdered, washed, or pulverized, 15 per centum ad valorem."

"621. (Free list.) Talcum, steatite, and French chalk, crude and unground."

DESCRIPTION.

Talc is a mineral of creamy white, grayish, or greenish color and is recognized by its useful properties, which are its softness, soapy or greasy feel, and its resistance to the action of heat and acids. Chemically, it is an acid metasilicate of magnesium composed of 63.5 per cent of silica, 31.7 per cent of magnesia, and 4.8 per cent of water. Ground talc, or talcum, is the most familiar form in which this mineral is marketed.

Steatite is a massive rock, which is commonly known as *soapstone.* It is composed chiefly but not wholly of talc, and since talc is a soft mineral and easily broken, soapstone is a weak rock and not well suited for structural uses. It is quarried in large blocks, which are sawn into slabs of varying dimensions according to the use for which it is intended.

"*French chalk*" is a misnomer, because it is a species of talc (magnesium metasilicate) and not of chalk, which is calcium carbonate *French chalk* is commonly used synonymously with steatite or soapstone and in general refers to the pieces cut into sticks, cubes, or disks to be used by tailors for marking cloth.

USES.[1]

Talc and soapstone are used for a wide variety of purposes, which with the exception of the relatively small use in toilet powders, are not generally well known. By far the largest quantity of ground talc is consumed in the manufacture of paper. It serves as a filler in all grades of paper and is an important ingredient in various coating and glazing mixtures for finished paper. Talc is also used as a filler in textile, rubber, soap, linoleum, roofing paper, and rope and twine. The rubber industry uses ground talc for dusting and packing rubber goods and as a protective coating for crude rubber.

Talc is known to the paint trade as asbestine, talcose, ground soapstone, and talc. It is used as a pigment to absorb various complex coloring matters, and also, especially in mixed paints, it is used as a filler or extender. Asbestine, which usually refers to a fibrous form of talc from New York, has been recommended for the manufacture of the so-called fireproof or fire-resistant paints.

[1] Ladoo, in Reports of Investigations, U. S. Bureau of Mines, May, 1920, lists over 60 important uses for talc and soapstone.

Other uses for talc are as a covering for steam pipes and in wire insulating compounds, in toilet preparations, in leather manufacture, as a filtering medium for refining oil, for polishing plate glass, and for dimming and clouding opaque glass, as an ingredient of certain special cements, and as a dusting agent to prevent sticking in foundry molds. The large number of less important uses can not be tabulated here.

Massive talc and soapstone are largely used for preparing lava blanks for electrical insulation and for gas-burner tips. Crayons and pencils used for marking steel and iron are also made in large quantities. The compact and strong but medium soft variety of talc is used in preparing tailors' crayons (so-called French chalk). The ease with which soapstone may be worked has resulted in a large use for the manufacture of soapstone slabs. These are used as electrical switchboards, in laundry tubs and sinks, as acid-proof laboratory tables, sinks, and tanks, in fireless cookers, and for griddles and foot warmers. Many other uses are already known and continue to be discovered.

SUBSTITUTES AND RIVAL COMMODITIES.

The greatest competitor of talc in the paper trade is English clay, especially the white porcelain clay. Talc, especially the fibrous variety, probably gives greater strength and flexibility than clay, but is more expensive. Zinc oxide, gypsum, barytes, and chalk are also used as fillers for paper, rubber, and paints. Talc used for dusting rubber goods in certain factory operations is reported to be detrimental to the health of the operatives and has been replaced to some extent by starch.

Another mineral, pyrophyllite, a hydrous silicate of alumina, resembles talc in some of its properties and is useful for the same purposes. It is mined and sold as talc at Glendon, Moore County, N. C.[1]

THE INDUSTRY IN THE UNITED STATES.

Importance.—The United States produces and consumes more talc and soapstone than any other nation. The domestic output has exceeded 200,000 tons per annum, valued at over $2,250,000. In addition to the domestic production, about 18,000 to 20,000 tons of talc are imported annually. The United States is well supplied with low and middle grades of talc suitable for paper, but is deficient in high-grade material for toilet powder, pencils, and gas (lava) tips.[2]

Occurrence.—Talc commonly occurs associated with limestone, principally in the mountainous belt along the Atlantic and Pacific coasts. The former region furnishes 95 per cent of the total domestic output and about 5 per cent comes from California. The Mississippi Valley and the Great Basin contain no commercial talc mines.

Soapstone occurs in the same region in which talc is found, but by far the most important domestic quarries are located in Belson, Albemarle, and Orange Counties, Va. The quarries supply over 90 per cent of the total output, the remainder being obtained from California and Vermont.

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[1] Diller, J. S., Talc and Soapstone in 1918, Mineral Resources, 1918, Part II, p. 558 (1920).
[2] Diller, J. S., *op. cit.*

Mining and quarrying.—Talc seldom reaches the market in the crude form, for the mills are usually located near the mines and are owned by the mine operators. After the ore is mined, the dry material is crushed in a jaw crusher, which gives a product an inch to an inch and a half in diameter. This is reduced to a half-inch by passing it between rollers in a rotary crusher, and finally pulverized in a burrstone or emery mill. The different grades of the product are separated by air separators or by screening.

Soapstone is quarried in the form of blocks, which are shipped to the mills, where they are sawn, planed, turned, and grooved in preparation for the manufacture of laundry tubs and sinks.

Domestic production.—The Geological Survey reports that in 1918 there were 31 domestic producers of talc, of whom 8 were in California, 6 in Vermont, 6 in North Carolina, 3 in New York, 2 each in Georgia, Maryland, and Pennsylvania, and 1 each in Massachusetts and New Jersey.

New York had been the principal producing talc State until, both in 1917 and again in 1918, Vermont surpassed the New York production in quantity, but not in value. These two States produced approximately four-fifths of the total production.

In 1918 Vermont had an output of 90,537 short tons, valued at $775,012. New York reported sales of 71,167, valued at $902,100. California, ranking third, in 1918 had an output of 10,364 tons, valued at $170,775, which was more than two and one-half times this State's output in 1917. The average price per ton for the New York output in 1918 was $12.68; for Vermont, $8.56; for North Carolina, $43.56; and for the total production was $10.91.

Soapstone is produced principally by three large quarries in Virginia, from a belt running northeastward through Nelson, Albemarle, and Orange Counties. California and Vermont, each has one producing plant, and together yield nearly one-tenth as much as Virginia.

Virginia furnishes practically all of the soapstone produced in this country, and the production of this State alone probably exceeds the combined output of all nations other than the United States. In 1917 the output in Virginia was 20,235 tons. Of the 19,652 tons produced in 1916, 15,569 tons consisted of manufactured articles—griddles, fire ends,—etc.having an average value of $26.79; 3,558 tons consisted of material sawn for laundry tubs, table tops, etc., and was valued at $20.38 per ton; 525 tons were sold as crude material at an average price of $2.58 per ton. The production of soapstone in 1918 amounted to 16,830 tons, valued at $591,059.

IMPORTS.

The total quantity of talc imported for consumption in the United States has not in recent years exceeded 10 per cent of the domestic production. No imports of soapstone have been reported. A large proportion of the imported talc is of high grade, and in general is not competitive with domestic talc, since it is suitable for different uses. In former years Italy and France were the most important sources of imported talc, but since 1917 most of the imports have

come from Canada. Canadian talc, which is mined in the Province of Ontario, commands a slightly higher price than the domestic product. Italy has formerly been the chief source of the talc for toilet powder, while France furnishes much of the so-called French chalk used by tailors and in crayons.

The imports of talc during recent years have ranged between 25 and 40 million pounds. About 10 per cent of this is crude and the remainder is ground talc. The imports during the fiscal year 1920 reached a maximum of 36,579,129 pounds of ground talc, valued at $365,822, and 2,958,482 pounds of unground, valued at $10,254.

Imports of French chalk have only been shown separately in official statistics since 1914. The maximum quantity in recent years was received in 1914, and was valued at $1,687. The quantity of the imports was shown for the first time in 1919 (calendar year) and amounted to 6,313 pounds, valued at $323.

EXPORTS.

Exports of neither talc nor soapstone have been reported separately in the official export statistics.

THE INDUSTRY IN FOREIGN COUNTRIES.

The production of talc and soapstone in the various foreign countries during recent years is compared with that of the United States in the tables shown on page 18. These figures, which were supplied by the United States Geological Survey, show that the United States produces over half of the world's supply of talc. Of the world's production in 1918 the United States produced 58 per cent and consumed nearly 63 per cent, leaving approximately 37 per cent for consumption by the rest of the world.

France ranks second to the United States in the production of talc. The well-known French chalk comes from southeastern France near Toulon. In 1913 France produced more than 66,000 short tons. During the war there was a great decrease in production and exports. It is believed, however, that the productive capacity will again be reached within a few years.

Italy is the source of a variety of talc which is highly prized for use in the manufacture of toilet powder. The talc-producing section of Italy is in Piedmont, south of Turin. The export figures to the United States in recent years are: in 1913, $91,936; in 1914, $128,388; in 1915, 12,627,490 pounds, valued at $119,025; in 1916, 10,343,138 pounds, valued at $125,217; in 1917, 23,296,000 pounds; and in 1918, 9,702,000 pounds. (Commerce Report, Feb. 8, 1919.)

Deposits in South Africa have recently been exploited and may develop considerable importance. These were originally mined for their content of gold and were found to contain large reserves of talc. The talc can be easily and cheaply mined, and as the rail charge to port is only 3 s. 6d. per ton, it is believed that an export trade will be established as soon as shipping becomes available. The production, which thus far has been small, amounted in 1915 to 44 short tons, valued at $1,060; in 1916, to 132 tons, valued at $2,860; and in 1917, to 785 tons, valued at $9,530. Both talc and

soapstone are of wide occurrence in Brazil and have not been mined commercially. Deposits of a very pure white talc which requires little treatment to make it available as a cosmetic have been found in the State of Rio de Janeiro. Soapstone in Brazil is used principally in the manufacture of cooking utensils, such as pots and pans.

A very thorough discussion of the world's resources of talc and soapstone was published in October, 1919, in the Bureau of Mine's 'Monthly Reports of Investigations."

PRICES.

The prices of American and Italian talc remained practically stable until July, 1915, at which time the prices dropped to $6 and $18 per ton, respectively. The reason for this probably was the overstocked condition of the American market. However, in 1917 the prices rose very greatly, especially those for Italian talc, probably as the result of transportation difficulties and lack of labor. The price of French talc has been quite stable throughout the past 10 years, even during the war. The wholesale prices of American, French, and Italian talc at New York, 1910–1920, are shown on page 21.

Powdered soapstone was quoted at $10 and $12 per ton in August, 1914, and this price showed but little variation during 1915, 1916, and 1917. Toward the end of 1918 powdered soapstone was quoted at $15 and $25 a ton, and during 1919 the price fell to $12 and $17.50. In November, 1920, powdered soapstone was quoted at $15.20 per ton.

TARIFF HISTORY.

The act of 1883 contained a provision for "French chalk" under which it was dutiable at 20 per cent ad valorem. There was a similar specific provision in the act of 1890, but the rate was changed to 1 cent per pound. In 1894 the rate was returned to 20 per cent ad valorem, but in the acts of 1897 and 1909 it was again changed to 1 cent per pound. Under the act of 1913, talcum, steatite, and French chalk, crude and unground, enter free of duty, and the cut, powdered, washed, or pulverized material is dutiable at 15 per cent ad valorem.

TARIFF CONSIDERATIONS.

Ground talc.—The annual imports of ground and prepared talc are equivalent to about 8.5 per cent of the quantity of the domestic production of ground talc and to 13.5 per cent of the value of this production. These imports in recent years, have been as follows:

12 months ended—	Tons.	Value.	Value per ton.
June, 1917	17,151	$238,474	$13.90
June, 1918	13,713	265,979	19.35
June, 1919	11,545	207,534	17.95

During this time the American production of ground talc has been as follows:

Calendar year—	Tons.	Value.	Value per ton.
1916	181,182	$1,553,240	$8.60
1917	180,563	1,644,828	9.10
1918	177,269	1,869,730	10.55

The present duty of 15 per cent ad valorem is equivalent (on the basis of the 1917–1919 import values) to a specific duty of $2.50 per ton, or $0.00125 per pound. The slightly higher price of the imported talc is caused both by the inclusion of certain manufactures of talc, such as the blanks used for the manufacture of gas-burner tips, and by the fact that the material is of a higher grade and commands a higher price.

Crude or unground talc.—Imports of the crude talc have been as follows:

12 months ended—	Tons.	Value.	Value per ton.
June, 1917	1,868.4	$11,477	$6.25
June, 1918	2,361	10,528	4.55
June, 1919	1,402	10,324	7.35

The crude talc of domestic production marketed during this period has been as follows:

Calendar year—	Tons.	Value.	Value per ton.
1916	11,299	$106,928	$9.45
1917	12,269	68,440	5.60
1918	13,263	106,288	8.01

Manufactures of talc.—Imports of talc prepared in the form of blanks, crayons, cubes, etc., have not been shown separately in the statistics, but have been included in the figures for the ground and prepared talc. The domestic production of talc manufactured into pencils and blanks has been as follows:

Calendar year—	Tons.	Value.	Value per ton.
1916	828	$102,674	$124.00
1917	5,781	176,404	30.50
1918	945	114,002	120.00

Talc and soapstone—Production in United States.

[Taken from Mineral Resources, 1914.]

Years.	Quantity.	Value.	Value per unit.	Years.	Quantity.	Value.	Value per unit.
	Short tons.				*Short tons.*		
1910	150,716	$1,592,393	.....	1915	186,891	$1,891,582	$10.12
1911	143,551	1,646,018	$11.47	1916	212,961	.....	.....
1912	159,270	1,706,963	10.72	1917	216,848	.....	.....
1913	175,833	1,908,097	10.85	1918	208,307	2,681,019	12.87
1914	172,296	1,865,087	10.82				

Talc—Production in United States—States and cities.

[Taken from Mineral Resources, 1912-1914.]

States.	1912		1913		1914	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
New York	66,867	$656,270	81,705	$788,500	86,075	$821,286
Vermont	41,270	245,679	44,447	302,375	50,123	358,465
Pennsylvania and New Jersey	10,400	50,519	11,308	80,780	7,732	54,549
Georgia, Maryland, and Massachusetts	6,836	49,172	3,309	35,416	3,627	57,927
Virginia	3,255	17,186	2,974	16,632	1,786	11,448
North Carolina	3,492	63,004	4,576	48,317	1,198	28,413
California	1,169	15,653	952	6,000	547	8,786
Total	133,289	1,097,483	149,271	1,280,020	151,088	1,340,874

States.	1915		1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
New York	88,214	$864,843	93,236	$961,510	74,671	$881,462	71,167	$902,100
Vermont	61,997	406,652	73,215	501,175	93,960	625,150	90,537	775,012
Pennsylvania and New Jersey	7,989	56,466	8,222	59,331	[1] 13,404	87,124	.....	.....
Virginia	3,036	18,579	8,798	73,622	6,432	85,856	3,265	24,723
Georgia and Massachusetts	2,934	25,971	6,921	111,686	[2] 3,819	94,314	.....	.....
North Carolina	1,454	21,501	1,787	41,824	2,175	41,766	1,661	72,348
California	712	7,185	1,130	13,694	4,152	74,000	10,364	170,775
All other	.....	.....	.....	.....	.....	.....	14,483	145,002
Total	166,336	1,401,197	193,309	1,762,842	198,613	1,889,672	191,477	2,089,960

[1] Includes also Maryland and Massachusetts. [2] Georgia only.

Soapstone—Production in United States—States and cities.

[Taken from Mineral Resources, 1912-1918.]

States.	1912		1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Maryland, North Carolina, Rhode Island, Vermont	*Short tons.* 3,923	$50,193	*Short tons.* 3,049	$31,151	*Short tons.* 1,307	$7,723	*Short tons.* 850	$4,222
Virginia	22,058	559,287	23,513	596,926	19,901	516,490	19,705	486,163
Total	25,981	609,480	26,562	628,077	21,208	524,213	20,555	490,385

Soapstone—Production in United States—States and cities—Continued.

States.	1916		1917		1918		1919 [1]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		Short tons.		Short tons.		Short tons.	
Virginia	(2)		20,235	[3] $510,000				
Total	19,652	$490,960	20,235	[3] 510,000	16,830	$591,059	18,000	$600,000

[1] Estimated. See "Preliminary summary," Mineral Resources, 1919.
[2] Nearly all.
[3] Estimated.

Talc and soapstone—Production in principal countries.

Country.	1905	1906	1907	1908	1909	1910
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
United States	96,634	120,644	139,810	117,354	130,338	150,716
Argentina			28	7		
Canada	500	1,234	1,534	1,016	4,350	7,112
France	25,956	29,061	38,262	37,053	38,433	42,316
Germany	2,064	2,131	2,203	2,424	2,567	3,398
India	13	11	9	856	652	274
Italy	7,154	9,624	13,574	12,048	13,228	13,727
Spain	4,810	3,978	15,294	5,214	6,154	5,142
Total	137,131	193,683	210,714	175,972	195,722	222,685

Country.	1911	1912
	Tons.	Tons.
United States	143,551	159,270
Austria	15,212	
Canada	7,300	8,270
France	51,050	60,629
Germany	3,781	3,551
India	690	787
Italy	17,218	17,901
Spain	6,225	
Ireland		9
Madagascar	2	
South Africa	7	6
Total	245,036	250,423

Mineral Resources 1912, pt. 2. and Mineral Industry, 1916.

World's production of talc, 1913–1918, in principal countries.

[In metric tons.]

[Source: Mineral Resources, 1918, Pt. II, p. 562, U. S. Geol. Survey (1920).]

Country.	1913	1914	1915	1916	1917	1918	Per cent of total, 1918.
United States	135,417	137,066	150,898	175,368	180,180	173,706	59
France	60,175					57,588	19
Italy	24,001	22,477	23,931	27,483	21,863	23,951	8
Canada	11,113	9,804	10,782	11,888	14,336	16,502	6
Austria	16,000	15,000	12,000	12,000	12,000	12,000	4
Norway	1,500	2,100	2,990	5,500		3,023	1
Spain	4,407	4,612	963	3,556	3,450	3,328	1
Germany						3,000	1
India	2,565	1,015	1,094	1,233	7,954	2,772	1
British South Africa				120	712	608	
Total						296,478	100

World's production of soapstone (as far as available), 1913–1918, in principal countries.

[Source: Mineral Resources, 1918, Pt. II, p. 563. (U. S. Geological Survey, 1920.)]

[In metric tons.]

Countries.	1913	1914	1915	1916	1917	1918
United States	24,097	19,240	18,647	17,828	18,357	15,268
United Kingdom	40	180	850	301	1,233	936
Total	24,137	19,420	19,497	18,129	19,590	16,204

Talc, ground or prepared (dutiable)—Imports by countries (fiscal years).

Imported from—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	1,539,133	$13,931	1,174,976	$11,857	1,281,884	$16,655
France	7,396,873	22,604	3,580,501	12,687	7,928,761	21,025
Italy	8,042,681	71,965	6,531,256	49,693	8,078,215	60,750
Canada	1,071,068	6,242	1,282,772	7,267	2,804,223	15,578
All other	109,116	704	308,787	2,350	1,163,728	3,106
Total	18,158,871	115,446	12,878,292	83,854	21,256,811	117,114

Imported from—	1913		1914		1915	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	1,101,611	$11,703	1,064,429	$10,273	807,364	$8,695
France	8,593,706	22,223	12,138,883	31,340	4,845,928	12 213
Italy	8,870,875	63,691	8,838,858	64,484	13,819,223	97,039
Canada	5,329,244	26,587	7,296,348	35,199	10,789,271	65,560
All other	97,787	934	198,593	7,227	149,381	4,128
Total	23,993,223	125,138	29,537,111	148,523	30,411,167	187,635

Imported from—	1916		1917		1918	
	Pounds.	Value.	Pounds.	Value.	Pounds	Value.
France	8,586,686	$25,214	5,599,605	$15,634	751,670	$4,519
Italy	14,347,386	115,319	13,298,942	124,256	2,814,477	62,374
Canada	10,443,285	66,333	15,073,759	95,373	23,772,600	198,229
All other	None.	None.	330,737	3,211	87,240	857
Total	33,377,357	206,866	34,303,043	238,474	27,425,987	265,979

Imported from—	Calendar year.			
	1918		1919	
	Pounds.	Value.	Pounds.	Value.
France	43,132	$491	325,665	$7,236
Italy	980,778	36,575	1,915,430	40,565
Canada	24,370,925	214,036	23,704,355	202,447
Total	25,394,835	251,102	25,945,450	250,248

Talcum, ground talc, etc., cut, powdered, washed, or pulverized—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1908	20 per cent	18,894,220	$117,032	$23,406	$0.006	20.00
1909	do	14,767,760	94,761	18,952	.006	20.00
1910	do	501,252	3,767	753	.007	20.00
	35 per cent	17,976,403	113,118	39,591	.006	35.00
1911	do	12,521,335	81,773	28,620	.007	35.00
	20 per cent [1]	132,000	1,014	202	.008	20.00
1912	do	20,465,942	117,094	23,418	.006	20.00
1913	do	23,660,095	122,623	24,524	.005	20.00
1914	do	7,096,220	34,881	6,976	.004	20.00
	15 per cent	22,593,872	114,774	17,216	.005	15.00
1915	do	30,434,850	187,871	28,180	.006	15.00
1916	do	33,738,067	207,179	31,076	.006	15.00
1917	do	34,288,429	238,479	35,771	.007	15.00
1918	do	27,550,409	267,265	40,089	.009	15.00
1919 [2]	do	23,090,219	207,534	31,130	.009	15.00
1920	do	36,579,129	365,822	54,873	.010	15.00

[1] Treasury Decision No. 31635.
[2] During the calendar year 1919 there were received 6,313 pounds of "French chalk, cut, powdered, washed, or pulverized." The reported value was $323 and the duty collected (15 per cent ad valorem) amounted to $48.45.

Talcum, steatite, and French chalk, crude and unground—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914 [1]	Free	2,807,974	$23,369		$0.008	
1915	do	3,478,711	15,322		.004	
1916	do	4,681,165	9,703		.002	
1917	do	3,736,899	11,477		.003	
1918	do	4,721,980	10,528		.002	
1919	do	2,804,000	10,324		.004	
1920	do	2,958,482	10,254		.003	

[1] For imports in years prior to 1914 see "Survey of chalk."

French chalk, cut, powdered, washed or pulverized—Imports for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1914	15 per cent		$1,687	$253		15.00
1915	do		278	41		15.00
1916	do		583	87		15.00
1917	do		233	34		15.00
1918	do		174	26		15.00
1918 [1]	do		266	40		15.00
1919 [1]	do	6,313	323	48	$0.051	15.00

[1] Calendar year.

Talc—Prices per ton, wholesale, New York.

[From Oil, Paint, and Drug Reporter.]

AMERICAN.

Year.	Jan. 1.	Apr. 1.	July 1.	Oct. 1.	August.	Lowest.	Highest.
1910	$15–$25	$15–$25	$15–$25	$15–$25	.....	.....	.....
1911	15– 20	15– 20	15– 20	15– 20	.....	.....	.....
1912	15– 20	15– 20	15– 20	15– 20	.....	.....	.....
1913	15– 20	15– 20	15– 20	15– 20	.....	.....	.....
1914	15– 20	15– 20	15– 20	15– 20	$15–$20	.....	.....
1915	15– 20	15– 20	9– 13	9– 13	.....	$9.00	$20.00
1916	9– 13	9– 13	9– 13	9– 13	.....	9.00	13.00
1917	10– 13	10– 13	15– 18	15– 18	.....	.....	.....
1918	15– 22	15– 22	20– 40	20– 40	.....	.....	.....
1919	20– 40	20– 40	20– 40	20– 40	.....	.....	.....
1920	20– 40	20– 40	18– 20	18– 20	.....	.....	.....

FRENCH.

1910	$18–$20	$18–$25	$18–$25	$18–$25	.....	.....	.....
1911	15– 25	15– 25	15– 25	15– 25	.....	.....	.....
1912	15– 25	15– 25	15– 25	15– 25	.....	.....	.....
1913	15– 25	15– 25	15– 25	15– 25	.....	.....	.....
1914	15– 25	15– 25	15– 25	15– 25	$15–$25	.....	.....
1915	15– 25	15– 25	15– 20	15– 20	.....	$15 00	$25.00
1916	15– 20	15– 22	15– 22	15– 22	.....	15.00	22.00
1917	15– 22	15– 22	15– 22	15– 22	.....	.....	.....
1918	(1)	15– 22	.....	(1)	.....	.....	.....
1919	(1)	(1)	(1)	(1)	.....	.....	.....
1920	(1)	(1)	30	30	.....	.....	.....

[1] Nominal.

ITALIAN.

1910	$35–$40	$35–$40	$35–$40	$35–$40	.....	.....	.....
1911	35– 40	30– 35	30– 35	30– 35	.....	.....	.....
1912	35– 40	35– 40	35– 40	35– 40	.....	.....	.....
1913	35– 40	35– 40	35– 40	35– 40	.....	.....	.....
1914	35– 40	35– 40	35– 40	35– 40	$35–$40	.....	.....
1915	35– 40	35– 40	18– 30	18– 30	.....	$18	$40
1916	18– 30	18– 30	20– 35	20– 35	.....	18	35
1917	35	35	35	60	.....	.....	.....
1918	(1)	(1)	(1)	(1)	.....	.....	.....
1919	(1)	(1)	(1)	(1)	.....	.....	.....
1920	(1)	(1)	50– 60	50– 60	.....	.....	.....

[1] Nominal.

Talc—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	46	* * * French chalk, * * *.....	20 per cent ad valorem.
1890	16	Chalk, * * * French, * * *.....	1 cent per pound.
1894	11	.....do.....	20 per cent ad valorem.
1897	13	* * * French chalk.....	1 cent per pound.
1909	13	.....do.....	Do.
1913	69	Talcum, ground talc, steatite, and French chalk, cut, powdered, washed, or pulverized.	15 per cent ad valorem.
	621	Talcum, steatite, and French chalk, crude and unground.....	Free.

COURT AND TREASURY DECISIONS.

Talc in various forms and under the names soapstone, steatite, or French chalk, as well as talc, has been repeatedly the subject of litigation. So-called French chalk has, upon the particular record in each case, been classified as French chalk, as talc, as an unenumerated manufactured article, and as undecorated ware composed of mineral substances. (G. A. 1196, T. D. 12458; G. A. 3244, T. D. 16526; G. A. 3617, T. D. 17478; G. A. 5521, T. D. 24864; G. A. 6665, T. D. 28425; Kraemer *v.* United States, 180 Fed., 639.) But in the latest case French chalk was declared a misnomer because a species of talc rather than chalk. (Salomon *v.* United States, 2 Ct. Cust. Appls., 92; American Lava Co. *v.* United States, 3 Ct. Cust. Appls., 522, and cases therein cited.)

Small pieces of soapstone cut in regular sizes and used in the manufacture of gas burners were held dutiable as unemunerated manufactured articles under section 6 of the act of 1897 and not exempt from duty as "lava, unmanufactured," under paragraph 595, nor as "minerals, crude," under paragraph 614. Paragraph 97 of that act relating to mineral substances was construed not to embrace, either directly or by similitude, articles not susceptible of decoration. (Kirschberger *v.* United States, T. D. 29391.)

Powdered talc to which a small quantity of boric acid has been added, the use and purpose of which are as a toilet preparation for application to the skin, has been held classable for tariff purposes under paragraph 48 rather than paragraph 69 of the act of 1913. (Roger *v.* United States, 7 Ct. Cust. Appls., 89.)

VANILLIN.

[Par. 70, act of 1913, 10 cents per ounce.]

General Information.

DESCRIPTION AND USES.

Vanillin is the aldehyde of vanillic or methylprotocatechuic acid, which is present in vanilla beans. True extract of vanilla beans contains vanillin, the chief aromatic constituent. Artificial vanillin is obtained by a chemical process from oil of cloves; it is dissolved in alcohol and the solution colored with caramel in imitation of the true extract of vanilla beans. This artificial extract is generally cheaper and is a strong competitor with the natural or genuine vanilla extract. An extract of tonka beans is sometimes sold as a substitute for vanilla extract. The genuine and artificial product are both used as food flavors, in liqueurs, and in pharmaceutical preparations.

PRODUCTION.

Vanilla extract is made from the vanilla beans by extracting the aromatic resins with alcohol. Artificial vanilla extract (vanilla essence, vanillin) is made chiefly from oil of cloves by a chemical process involving the use of acetic anhydride, potassium permanganate, and sulphuric acid. In 1914, 120,619 pounds of vanillin, valued at $525,219, were produced in the United States. Vanillin is also produced in foreign countries, including Switzerland and France.

Vanillin—Imports for consumption.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Average ad valorem rate.
		Ounces.	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1908	80 cents per ounce.	1,764	396	1,411	0.225	356.36
1909	do	361	80	288	.222	361.00
1910	do	888	219	710	.247	324.38
	20 cents per ounce.	3,192	729	638	.228	87.57
1911	do	140	34	28	.243	82.35
1912	do	1,924	402	384	.209	95.72
1913	do	880	171	176	.194	102.92
1914	do	2,244	460	448	.205	97.57
	10 cents per ounce.	31,424	5,986	3,142	.190	52.50
1915	do	451	98	45	.217	4.60

Vanillin [1]—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1897	86	Vanillin, per ounce	80 cents.
1909	83	do	20 cents.
1913	70	do	10 cents.

[1] Not mentioned prior to the act of 1897.

VANILLA BEANS.

[Par. 70, act of 1913, 30 cents per lb.]

General Information.

DEFINITION.

Vanilla beans are the cured, full-grown, unripe fruit of *Vanilla planifolia* Andrews (family Orchidaceae).

RELATED PRODUCTS, SUBSTITUTES, AND ADULTERANTS.

The genus Vanilla includes several species besides the official *V. planifolia.* Only one is of commercial importance—*V. pompona* Schiede of South America, and Mexico, yielding the vanillons of commerce. This species has been cultivated somewhat outside its native habitat, but has generally been replaced by the more valuable true vanilla.

Vanillin, the chief aromatic constituent of cured vanilla, has been derived by various synthetic processes. (See surveys on Vanillin, par. 70, and synthetic perfume materials, par. 49.) Of chief importance in this country is its manufacture from eugenol, the chief constituent of oil of cloves. Vanillin can be produced much more cheaply from eugenol than from vanilla; therefore the synthetic product is the chief commercial rival of the latter. Its production on a large scale has operated to reduce the price of and demand for true vanilla, but the "bean" is still commercially valued much more highly than its equivalent in vanillin. Vanilla is said to contain small quantities of other aromatic ingredients, probably of a balsamic nature, which give its preparations a characteristic flavor and superior permanence which can not be attained by the use of pure vanillin. A considerable popular demand exists, also, for a "pure product," even at a considerably higher price.

Tonka beans and coumarin are also used as vanilla substitutes in the adulteration of flavorings.

CULTURE OF VANILLA.

The plant is a perennial climbing orchid. It is a native of the tropical forested valleys of the eastern Mexican Andes, where it was cultivated by the natives before historic time. It requires a tropical climate, hot and moist, with frequent but not excessive rains. It can not tolerate dryness or strong sea winds. A dry period in the summer, however, is said to be essential to good flowering. The chief plantations are situated in altitudes from sea level to 2,000 feet.

The fruit of the vanilla plant is a pod usually from 6 to 10 inches long and about one-third inch thick, dark-brown and leathery in appearance. The fruit draws its commercial name "bean" from its

very superficial resemblance to the pod of a common bean; it has no botanical claim to such designation.

The "beans" are gathered just before ripening, quite frequently too soon by thieves or by the owner to prevent theft. These immature fruits are as large as the properly gathered article, but are inferior in quality, strength, and keeping qualities. Those which are missed at the first picking are gathered later, usually in poor condition, and are cut into pieces and sold as "cuts." Those which are left on the vine till maturity split into three valves, and this also occurs during curing if the pods are mature; such pods are sold as "splits" at a lower price.

CURING VANILLA "BEANS."

The vanilla pod, as gathered, contains no vanillin, and the curing process by which this is developed requires greater attention and care than any subsequent proceeding; it is upon this process that the value of the product depends.

YIELDS AND PROFIT.

Vanilla produces 100–125 pounds of marketable fruit per acre. Costs and returns are extremely variable, as may be readily imagined in view of the wide range of localities in which the product is grown and the equally notable variations in the price of the article, both between grades and from year to year for the same grade. Ridley cites the profit per acre in the Seychelles as about $1,200, in Tahiti $580, in Honolulu $453, in Australia $300. Prices of vanilla in recent years have declined owing both to occasional overproduction and the competition of artificial vanillin. London prices, from £9 per pound in 1890, declined to £1 1s. in 1903. For recent New York prices of several grades, reference may be made to page 28.

VANILLA IN MEXICO.

Vanilla occurs wild in Mexico; the wild product is gathered, but is inferior to the cultivated. The culture of vanilla antedates the coming of the Spaniards. The industry centers in Papantla, Misantla, Vera Cruz, and Oaxaca Provinces; imports go chiefly via Vera Cruz. Mexican vanilla is the highest priced grade, and is exported most largely to the United States.

VANILLA IN THE FRENCH COLONIES.

Wild vanilla is exported by French Guiana; little cultivation occurs there. Guadaloupe furnishes a variable amount of cultivated vanilla to France, the French colonies, and the United States. Guadaloupe vanilla is more or less synonymous with "South America." Cultivation is said to be dying out in Martinique. Reunion, or Isle of Bourbon, ranks second only to Mexico in the quality of its exports, and stands about third in production. Madagascar and the Comoro Islands produce important amounts. Vanilla has been cultivated experimentally with good results in the French Congo. Tahiti, as far as records have been available, is the world's largest producer of

vanilla, but the product of this island is the lowest grade commonly quoted, bringing one-fourth to one-eighth the price of Mexican vanilla. This lack of value is said to be due in part at least to improper curing. Vanilla from the French colonies goes in general to France, and is largely exported thence.

VANILLA IN THE BRITISH COLONIES.

Vanilla was for many years the main product of the Seychelles; these islands ranked with Reunion in amount produced. In 1904 the vines suffered severe injury from drought, about half the number being killed. The decreasing price of the article has also played a part in the diminution of the cultivation. Mauritius, the Antilles, the Fijis, Ceylon, and Zanzibar produce comparatively small amounts of vanilla. Seychelles and Mauritius vanilla is frequently sold as inferior Bourbon. The produce of the English colonies goes chiefly to England.

VANILLA IN OTHER LOCALITIES.

Wild vanilla occurs in Dutch Guiana, but cultivation here has not been very successful. Holland's chief supply is drawn from Java.

Vanilla has been cultivated in a more or less experimental manner and with varying success in Australia, Africa, India, and many tropical islands, but none of these are at present important in commerce.

USES OF VANILLA.

Vanilla is chiefly used as fluid extract, tincture, or "essence," as flavoring for chocolate, confectionery, various articles of food, in liqueurs, and in pharmaceutical preparations.

As a drug vanilla is scarcely used for its own effect; while it has some reputation as a carminative, stimulant, and aphrodisiac, it has no important medicinal properties.

Vanillons, the fruit of *V. pompona*, referred to under "Related products," contain heliotropin instead of vanillin; they are used in perfumes and in tobacco manufacture.

Vanilla beans—General imports by countries (fiscal years).

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mexico	264,532	$655,718	251,931	$706,097	357,857	$1,101,104
France	330,510	576,513	101,955	239,107	138,486	381,343
French Oceania	445,869	171,118	407,804	176,015	617,096	410,822
French West Indies	49,190	39,964	17,697	36,680	9,670	12,143
England	16,721	27,495	16,425	41,710	13,071	35,891
British West Indies	79	166	.....	.....	107	148
French Africa	.....	.....	.....	.....	.....	.....
Germany	12,773	19,264	1,332	3,236	3,498	9,702
All other	1,811	5,231	265	928	865	2,219
Total	1,121,485	1,495,469	797,409	1,203,773	1,140,650	1,953,372

Vanilla beans, free [1]*—Imports by countries (fiscal years).*

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mexico	277,587	$896,029	421,972	$1,327,331	199,746	$635,439
France	167,810	535,705	226,565	616,223	38,036	98,243
French Oceania	325,264	429,701	341,736	570,202	155,440	290,876
French West Indies	45,589	83,205	35,706	67,075	.....	.....
England	16,428	54,677	16,759	41,979	3,228	8,802
British West Indies	664	2,359	.....	.....	.....	.....
French Africa	1,779	5,495	.....	.....	556	1,178
Germany	4,719	13,462	4,329	12,114	.....	.....
All other	1,788	4,520	2,430	6,649	427	728
Total	841,628	2,025,153	1,049,497	2,641,573	397,433	1,035,266

[1] Reports for 1915 and 1916, also 1914, dutiable on another sheet.

Vanilla beans, dutiable—Imports by countries (fiscal years).

Imported from—	1914 [1]		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mexico	194,226	$583,113	396,223	$1,137,771	302,923	$691,733
France	112,405	290,953	157,709	309,922	301,567	633,965
French Oceania	157,743	284,096	291,280	361,126	202,913	224,305
French West Indies	18,926	42,346	28,898	31,192	52,213	63,440
England	8,935	21,963	5,481	8,551	10,108	18,203
British West Indies	534	992	251	213	9,683	10,343
French Africa	.....	.....	.....	.....	1,099	1,757
Germany	3,576	8,649	303	215	.....	.....
All other	4,327	10,297	8,424	14,525	33,880	50,797
Total	500,667	1,242,409	888,569	1,863,515	914,386	1,697,543

[1] Total free and dutiable for 1914, 898,100 pounds, valued at $2,277,675.

Vanilla beans—Imports by countries.

Imported from—	Fiscal year 1917.		Calendar year—			
			1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mexico	185,055	$651,348	100,559	$221,573	424,631	$931,709
France	286,515	572,396	463,436	714,574	553,531	1,177,769
French Oceania	223,011	253,570	.....	.....	112,120	210,642
French West Indies	36,673	76,338	68,030	113,311	20,036	29,866
British West Indies	1,597	1,839	22,533	40,584	20,308	28,871
French Africa	10,867	18,850	.....	.....	.....	.....
Madagascar	42,609	66,170	19,270	21,612	8,031	12,485
United Kingdom	10,270	15,759	1,750	2,003	4,023	7,758
All other	3,296	6,308	83,823	81,975	7,399	7,993
Total	799,893	1,662,578	759,401	1,195,632	1,150,079	2,407,093

Tonka beans—Imports for consumption—Revenue.

	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
Fiscal year—		*Pounds.*				*Per cent.*
1908	Free	25,635	$10,519		$0.410	
1909	do	442,576	216,887		.490	
1910	do	264,008	176,938		.670	
1911	do	23,218	27,616		1.190	
1912	do	91,024	201,131		2.210	
1913	do	783,888	1,140,409		1.450	
1914	do	531,723	667,968		1,260	
	25 cents per pound	13,483	9,227	$3,358	.687	36.40
1915	do	127,948	92,079	31,987	.719	34.74
1916	do	143,321	94,790	35,830	.661	37.80
1917	do	222,754	156,974	55,688	.704	35.48
1918	do	405,429	204,260	101,357	.503	49.62
Calendar year—						
1918	do	112,137	60,384	28,031	.543	46.43
1919	do	99,973	88,543	24,993	.885	28.23

Tonka beans—Prices per pound, wholesale, New York, spot.

[From Oil, Paint, and Drug Reporter.]

ANGOSTURA.

Jan. 1, 1912	$5.00–$5.25	Mar. 29, 1915	1.10– 1.15
Apr. 1, 1912	5.25– 5.50	June 28, 1915	.90– 1.00
July 1, 1912	5.50	Sept. 27, 1915	.90– 1.00
Sept. 30, 1912	6.50– 7.00	Jan. 3, 1916	.90– 1.05
Dec. 30, 1912	5.50– 6.00	Apr. 3, 1916	.90– 1.05
Mar. 31, 1913	5.00– 5.50	July 3, 1916	.80– .82½
June 30, 1913	5.00– 5.25	Oct. 2, 1917	.85– .90
Sept. 29, 1913	1.75– 2.00	Jan. 1, 1917	.90– .95
Dec. 29, 1913	1.60– 1.75	Apr. 2, 1917	.85– .95
Mar. 30, 1914	1.50– 1.60	July 2, 1917	.85– .95
June 29, 1914	1.50– 1.60	Oct. 1, 1917	.85– .95
Sept. 28, 1914	1.35– 1.50	Dec. 31, 1917	.90– 1.00
Dec. 28, 1914	1.50– 1.60		

PARA.

Jan. 1, 1912	$2.00–$2.25	Mar. 29, 1915	$0.75–$0.85
Apr. 1, 1912	1.50– 1.75	June 28, 1915	.65– .70
July 1, 1912	1.50– 1.75	Sept. 27, 1915	.65– .70
Sept. 30, 1912	2.50	Jan. 3, 1916	.65– .70
Dec. 30, 1912	2.50	Apr. 3, 1916	.65– .70
Mar. 31, 1913	2.50	July 3, 1916	.50– .55
June 30, 1913	2.50	Oct. 2, 1916	.50– .55
Sept. 29, 1913	1.10	Jan. 1, 1917	.55– .60
Dec. 29, 1913	(1)	Apr. 2, 1917	.55– .60
Mar. 30, 1914	(1)	July 2, 1917	.55– .60
June 29, 1914	(1)	Oct. 1, 1917	.55– .60
Sept. 28, 1914	1.10– 1.15	Dec. 31, 1917	.65– .70
Dec. 28, 1914	.85– .95		

[1] Nominal.

SURINUM, CRYSTALLIZED.

Jan. 1, 1912	$2.50	Mar. 29, 1915	$0.85–$0.90
Apr. 1, 1912	$2.25– 2.50	June 28, 1915	.85– .90
July 1, 1912	2.00– 2.25	Sept. 27, 1915	.75– .80
Sept. 30, 1912	4.00– 4.50	Jan. 3, 1916	.75– .80
Dec. 30, 1912	4.00– 4.50	Apr. 3, 1916	.75– .80
Mar. 31, 1913	4.00– 4.50	July 3, 1916	.70– .75
June 30, 1913	4.00– 4.50	Oct. 2, 1916	.60– .65
Sept. 29, 1913	(1)	Jan. 1, 1917	.60– .65
Dec. 29, 1913	(1)	Apr. 2, 1917	.65– .70
Mar. 30, 1914	(1)	July 2, 1917	.65– .70
June 29, 1914	1.10– 1.15	Oct. 1, 1917	.65– .70
Sept. 28, 1914	1.25– 1.30	Dec. 31, 1917	.70– .75
Dec. 28, 1914	.90– 1.10		

[1] Nominal.

Tonka beans—Rates of duty.

Act of—	Par.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	808	Tonquin, tonqua, or tonka beans	Free.
1890	739	....do	Do.
1894	656	....do	Do.
1897	685	....do	Do.
1909	697	....do	Do.
1913	70	* * * ; tonka beans, per pound	25 cents.